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ENGINEERING AND EQUIPMENT

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USSR REPORT

Engineering and Equipment

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/13046

AERONAUTICAL AND SPACE

OPTIMUM BEARING SURFACES OF WINGS WITH INTRICATE GEOMETRY FOR SUPERSONIC
FLIGHT

PROKHOROV, Ye.M., Novosibirsk

[Abstract] The bearing surface of a wing for supersonic flight is optimized
with respect to minimum strain and pitch. The optimum shape of this surface
is sought in the class of piecewise-constant functions describing it. The
problem is solved so as to satisfy all constraints of the linear theory and
with a high degree of smoothness. Use of two computation grids shifted from
one another eliminates the need for smoothing the resistance coefficients of
drag and lift. Calculations have been made for a delta wing with 76°-57°
broken-line front edges in the plan view, the target being to ensure non-
separation flow and zero load on the subsonic front edges at the supersonic
velocity $N_M = 2$. Figures 5; references 12: 11 Russian, 1 Western.
[95-2415]

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STRUCTURAL MATERIALS FOR WATER-MODERATED, WATER-COOLED POWER REACTOR VESSELS

GORYNIN, I.V., academician and ZVEZDIN, Yu.I., doctor of technical sciences

[Abstract] The Soviet commitment to expanding the nuclear power generating base, including water-moderated, water-cooled power reactors (VVER) requires substantiation of the long-term performance parameters of pressure vessels. This paper is an overview of Soviet and foreign materials science efforts to improve the steels used in reactors. Metallurgists in the USSR have devoted particular attention to the production of high purity steel and have developed the capability of producing steel ingots up to 300 tonnes with less than 0.01% phosphorus, less than 0.1% copper and with P + Sb + Sn totaling less than 0.015%. Extensive use of such steels in nuclear reactor construction will make it possible to build VVER vessels with a radiation service life of more than 50 years. Ways of improving the resistance of steels to brittle fracture are discussed in light of Soviet experimental and theoretical data on crack formation. Since it is difficult to reproduce all of the factors compromising the cyclical strength of reactor materials in the laboratory (high pressure and temperature environment, neutron flux exposure, considerable wall thickness, the stress load spectrum and coorosion effects), a single unified methodology has not yet been developed for calculating the service life of pressure vessels and the relevant standard setting functions do not appear in Soviet strength standards, although considerable progress has been made in the experimental study of the problem by the USSR Academies of Sciences. Direct nondestructive testing techniques for the condition of the metal in reactor materials must be developed, especially for the reactor core, and tests should be performed on scale models simulating worst case loads. Available test data on pipes in a VVER-1000 reactor indicate considerable strength reserves in the reactor materials, but new theoretical work is required to exploit these reserves. New programs for the study of the strength of pressure vessel models when loaded with internal pressure and simultaneously exposed to thermal shock are also needed. The interrelationship between the critical brittleness temperature and the destruction parameters of the reactor components following exposure to various neutron flux densities must also be established. Future needs for nuclear power require the reduction of the metal input requirements and increased reliability and service life of the reactor steels. Figures 4.
[276-8225]

MATERIOLOGICAL PROBLEMS ASSOCIATED WITH USE OF LITHIUM FUSION REACTOR BLANKET

GRYAZNOV, G.M., GOLUBCHIKOV, L.G., YEVTIKHIN, V.A., ZAVYALSKIY, L.P., KOSUKHIN, A.Ya., and LYUBLINSKIY, I.Ye.

[Abstract] Since metallic lithium is usable in a fusion reactor not only for production of tritium but also as coolant, an important design consideration is its liquid-phase interaction with structural materials and particularly its corrosive effect. Only a theoretical and semiquantitative analysis of this factor is possible, inasmuch as experimental data are scarce or unavailable. Most important are the behavior of austenitic stainless steels in liquid lithium, in which all three metals (Fe, Cr, Ni) are much more soluble than in liquid sodium or any other liquid alkali metals. The presence of non-metallic inclusions in these steels facilitates both penetration of liquid lithium and selective dissolution of steel components. A major undesirable consequence is degradation of the mechanical characteristics of such structural materials. Experimental studies made so far have established only rough and not necessarily consistent guidelines concerning the maximum temperatures at which structural materials will withstand contact with liquid lithium and have established no guidelines concerning the degree of purity required of metallic lithium for this particular application. The next problem is the effect of neutron bombardment on the compatibility of lithium with structural materials, only theoretical estimates being available on crumbling or swelling of chromium steels and even more so chromium-nickel steels. Possible transmutation of elements and resulting change of chemical composition must also be considered in the lithium-steel compatibility analysis. Another problem is the effect of a magnetic field, relevant only in consideration of tokamak fusion reactors. A magnetic field modifies the flow pattern of liquid lithium, effectively raising the velocity of the lithium stream with attendant effects on all structural materials, including intensification of selective corrosion and a less favorable scale formation pattern. All these obstacles to use of liquid lithium in the blanket of a fusion reactor can be overcome by counter-measures such as protective coatings or diffusion barriers on the surface of structural materials in contact with it and by addition of another metal to the liquid lithium, for instance 5% aluminum, which will form intermetallic compounds with component metals of the steel. References 33: 12 Russian, 21 Western (2 in Russian translation).
[117-2415]

FIELDS OF IONIZING RADIATIONS IN TOKAMAK-10 NUCLEAR FUSION PLANT

ZAVERYAYEV, V.S., BRITVICH, G.I., LEBEDEV, V.I., and LUKANIN, V.S., Soviet
Union, SPURNY, F., VOTOVKOVA,I., and HARVAT, I., Czechoslovakia

[Abstract] A study of the Tokamak-10 nuclear fusion plant as source of
ionizing radiations was made to determine the effectiveness of the radiation
shielding. The plant includes a transformer of cruciform construction with a
toroidal chamber filled with deuterium as secondary "winding", this torus
with an outer diameter of 150 cm and an inner diameter of 39 cm consisting of
inner 2nd outer stainless steel chambers with a 5 cm thick toroidal copper
shield between them. The outer chamber is surrounded by heavy coils gener-
ating a longitudinal magnetic field and its wall is shielded from the plasma
by tungsten or graphite diaphragms. The external radiation shield protecting
the environment is a 1 m thick and 5 m high wall of heavy concrete (density
3.6 g/cm^3). In the experiments thermonuclear discharge was produced with dis-
charge pulses of 1 s duration and plasma currents of 200-400 kA, neutron
emission of 10^{10} s^{-1} intensity occurring within approximately 0.6 s at a
sufficiently high temperature of 0.6-0.8 keV and ion density of $(5-8)\cdot10^{13}$ cm^{-3}
during the d+d fusion reaction. The dosimetric characteristics of individual
discharges and the average doses produced by series of 30-40 discharges were
determined on the basis of measurements made using a Geiger-Müller counter least
sensitive to neutrons for recording the bremsstrahlung in mixed neutron and
x-radiation fields, also using various ionization chambers and LiF, ^{7}LiF
thermoluminescence detectors for recording the bremsstrahlung, using an In-
foil and a BF_3-counter as detectors of thermal neutrons, using polystyrene
scintillators as detectors of the β^+-unstable ^{11}C isotope produced by
neutrons and γ-quanta, and using polyester track detectors with ^{232}Th, ^{235}U,
^{209}Bi fission fragments for measuring decay events, with spherical moderators
5.08-30.48 cm in diameter for spectrometry. The spectral characteristics were
evaluated according to SPEC and SAND calculation programs. Processing of all
the data has yielded not only the overall characteristics of ionizing radia-
tions and the energy spectrum of neutrons but also the spatial distribution
of radiation fields near the Tokamak-10 chamber where hard bremsstrahlung
is most dangerous, and of far fields where neutron radiation predominates.
None of these radiations was found to present a hazard to personnel. Figures
5; tables 1; references 12: 4 Russian, 3 Czechoslovak, 1 East German, 4
Western.
[99-2415]

DYNAMIC CHARACTERISTICS OF STEAM GENERATORS IN ATOMIC ELECTRIC POWER PLANTS
WITH VVER-440 MW WATER-MODERATED WATER-COOLED POWER REACTORS

PATSELYUK, S.N., engineer, SOKOLOV, A.T., engineer, and KAZAKOV, V.I.,
engineer, Southern Regional Engineering Management of Power Systems

[Abstract] Series of tests were performed on steam generators in the Rovno
AES with VVER-440 MW water-moderated water-cooled power reactors, the purpose
being to determine their dynamic characteristics and thus facilitate automa-
tion of the feedwater system. Water level and steam pressure were measured
during startup and during various perturbations such as drop of water flow
rate at full and partial load levels and drop of reactor power at nominal and
partial water flow rates, perturbations caused by cutout of the main circula-
tion pump, and perturbations caused by complete load dumping from both
turbines receiving steam from a generator. The results of this experimental
study reveal several peculiar features of these steam generators which must
be considered for optimum regulation. One of them is an initial steep change
of water level in the same direction as the load change, a consequence of the
swelling effect whose magnitude depends on that of the load change, followed
shortly by a change of water level in the opposite direction. Complete load
dumping from both turbines from nominal level or cutout of the main circula-
tion pump under full load cause large changes in water level. These changes
can be decreased by faster startup and by a higher response speed with a time
delay of level recovery than in boiler drums. Figures 4; references: 2
Russian.
[207-2415]

UNIQUE CRYOGENIC TURBO-GENERATOR DEVELOPED

Moscow RADIO in Russian 0500 GMT 24 Feb 86

[Summary of article]

[Text] Comprehensive testing of a 300,000 kW cryogenic turbo-generator
is under way at Elektrosila in Leningrad, fulfilling the most important of
their pre-Congress pledges. The new machine is one of a kind in the world.
Specialists consider cryogenerators to be the future of our power engineering.

/9716
CSO: 1861-366

COMBUSTION KINETICS OF POLYDISPERSE COKE DUST

GOLDOBIN, Yu.M., Ural Polytechnic Institute imeni S.M. Kirov, Sverdlovsk

[Abstract] Adiabatic combustion of polydisperse coke dust is analyzed, using the equation of kinetics which describes the size distribution of coke particles as a function of time: $\frac{\partial f(r,t)}{\partial t} + \frac{\partial}{\partial r}[f(r,t)W(r,t)] = 0$ (r- radius of particle, t- time, f- distribution function, W- combustion rate). This equation cannot be solved for function $f(r,t)$ by the Fourier method of separation of variables, but this function can be determined for extreme combustion modes. The corresponding problem of mass balance and heat balance is solved for the two extreme combustion modes: diffusion range (Nusselt number $Nu_d = 2 + br^m$, $Nu_d = br^m$ for large values of the Reynolds number) and kinetic range. Numerical results based on this theoretical approach agree closely with experimental data pertaining to burning of anthracite culm in the furnace of a TP-70 boiler. Figures 1; references: 11 Russian.
[84-2415]

DEGRADATION OF Cu_{2-x}S/CdS CERAMIC SOLAR CELLS

TORCHINSKAYA, T.V., MIRZAZHANOV, M.A., and MARCHENKO, A.I., Institute of Semiconductors, UkSSR Academy of Sciences

[Abstract] Ceramic solar cells of the Cu_{2-x}S/CdS class were studied in an experiment, the purpose being to monitor and explain their instability and attendant performance degradation. A lot of YeTO 0.21.009 TU CdS preforms was heat treated at 125°C for 60 min and a lot of BKO 0.28.014 TU CdS preforms was heat treated at 170°C for 30 min. Heterojunctions on the CdS

preforms were produced by chemical treatment with aqueous CuCl solution, using a vacuum deposited copper mesh as upper electrode and a fused-on indium bead as lower electrode. All solar cells produced from both lots were illuminated with light from a DKSSh-150 lamp through a water filter simulating the solar radiation spectrum. With a 100 W/cm^2 radiation power density in the plane of a solar cell, the degradation process was accelerated for testing purposes by heating a solar cell to 60°C and holding it in a thermostat at that temperature. Some solar cells of each lot were degraded in the short-circuit mode and others in the open-circuit mode. The degradation process was monitored over a period of 400 h, measurements included resistance of the CdS base at the same temperature and illumination level. That lot on YeTO 0.21.009 TU CdS preforms consisted of two groups, one with a low shunt resistance (1 kohm) and one with a high shunt resistance (40 kohm). Degradation of the first group in both modes was characterized by a monotonic decrease of the short-circuit current and the open-circuit voltage with a monotonic increase of the series resistance. Degradation of the second group in both modes was characterized by a slight decrease of the short-circuit current and an almost constant open-circuit voltage with an increase of the series resistance and of the CdS base resistance during the first 60 h, no further changes occurring during the next 340 h. Degradation of the lot on BKO 0.28.014 TU CdS preforms was characterized by an increase of the short-circuit current and a constant open-circuit voltage during the first 200 h, then a constant or only slightly decreasing short-circuit current and a constant open-circuit voltage during the next 200 h. An analysis of the data, including the spectral characteristics of the diode photocurrent, indicates a partial decomposition of copper sulfide in specimens heat treated at 170°C and no decomposition of copper sulfide in specimens heat treated at 125°C. Evidently copper "shorts" are completely removed by higher-temperature heat treatment but not quite all by lower-temperature heat treatment. In the former case degradation is probably caused by partial dissolution of donor precipitate in the CdS base under illumination. In the latter case degradation is probably caused by breakup of the supersaturated solid solution of donor defects in the CdS base and subsequent diffusion of copper atoms from "shorts" along grain boundaries into the grain. Figures 3; tables 1; references 5: 4 Russian, 1 East German.
[112-2415]

SELECTION OF PERIODIC SCAVENGING MODE FOR MARGINAL OIL WELLS WITH CONSIDERATION OF OIL EXTRACTION COST

MAKHMUDOV, Yu.A. and YELISEYENKO, A.M., Department of Automatic Control Systems, AzSSR Academy of Sciences

[Abstract] The effectiveness of periodically scavenging marginal deep oil wells is evaluated, for a determination of the optimum mode in terms of minimum

extraction cost. Calculations are based on the time parameters of the oil accumulation and pumping cycle, taking into account maintenance and repair costs. The mean length of the pumping period, on which the minimizable cost functional in this optimization problem depends, is treated as a slowly varying quantity and thus as a function of the length of the oil accumulation period only rather than also a function of time and of the point in the cycle at which pumping is to begin. Optimization over the entire period between overhauls is subsequently replaced with optimization over successive operating stages into which that period has been subdivided and which correspond to piecewise constant lengths of the pumping period. Assuming that the error in evaluation of the minimizable cost functional does not, as a result, increase beyond the permissible limit, simple algebraic equations are derived for the optimum pumping rate and the optimum timing of this operation as respectively a linear function and a quadratic function of the mean pumping time. The coefficients in these equations are determined empirically on the basis of technical and economic data pertaining to a particular well. The numerical results obtained by this method for well No 479 agree closely with those based on calculations by the Cherfas-Malina method. Tables 2; references: 4 Russian.
[202-2415]

INDUSTRIALIZATION OF BUILDING TURBINE CONDUITS FOR PUMPED-STORAGE HYDRO-ELECTRIC POWER PLANTS

ADLIN, Yu.M., engineer, BOZHIY, L.K., engineer, DONCHENKO, V.F., engineer, and NIKOLAYEV, B.A., engineer

[Abstract] The pumped-storage hydroelectric power plants being constructed in Zagorsk and in Kayshyadoris will require 125,000 m^3 of reinforced-concrete turbine conduit 7.5 m in diameter designed for a pressure head of 160 m. During the 1976-80 period the "Gidroproyekt" All-Union Planning Surveying and Scientific Research Institute of Water Power Construction imeni S. Ya. Zhuk and the Special Design Office at the "Mosgidrostal'" Moscow Institute of Water Power Steel Construction have developed a new technology of producing reinforced-concrete conduit sections and their subsequent mechanized assembly. The main special feature is an 8-10 mm thick inner steel shell which shares some tensile load with both helically laid inner and outer steel armors but principally insulates the concrete encasement from water. Conduit sections are assembled with a multipurpose drum and minimum amount of welding. The economic advantage of this new technology over the old one is significant, inasmuch as the material cost and the labor cost of installing 20,900 tons of conduit in the Zagorsk hydroelectric power plant should be respectively 1,046,000 rubles and 432,000 rubles lower. The labor productivity should be 2.45-2.9 times higher, moreover, with a reduction of the labor force by 70 men over the projected four-year period. Figures 6; references: 3 Russian.
[131-2415]

9

ELECTROCHEMICAL EXTRACTION OF PETROLEUM AND INCREASING PETROLEUM YIELD OF SEAMS. II. THEORY AND PRACTICE

NAZAROV, S.N., Tashkent Order of the Friendship of Peoples Polytechnical Institute imeni Abu Raykhana Beruni

[Abstract] The thermal effect of current injected into rock is investigated. The amount of power required, and the duration of application, are investigated for petroleum and gas-bearing seams containing water. Ways are investigated of reducing the duration of the application. It is found that thermoelectric treatment makes it possible to increase the yield of petroleum, and also to solve problems of extraction of paraffin, condenstate, salts, and water from oil and gas wells. Figures 1, tables 1, references 5: 4 Russian, 1 Western.
[225-6900]

COMPUTER-AIDED OIL EXPLORATION

GABRIELYANTS, G., doctor of geo-mineralogical sciences, and KONDRATYEV, O., doctor of physico-mathematical sciences

[Abstract] In order to accelerate oil and gas exploration in the Far East, in Eastern and Western Siberia, in Central Asia, in the Caspian Shore basin, and in the Northern European USSR, it is necessary not only to better organize the operation but also to speed up development of the geophysical scientific and technical base. The computerized seismic rig "Gorizont", the program-controlled coring rig "Skvazhina-2", and a digital electric exploration rig have already been built for this purpose. In practice, however, construction of new geophysical equipment proceeds at a very slow pace and mainly so because the available computer capacity is far too inadequate. It needs to be increased about sixfold, and special peripheral equipment is still required for interactive operation. Since geophysical exploration has so far been treated as an applied science only, prospecting is done on a semi-scientific and semicommercial basis with basic research being left lagging behind. A major problem is, moreover, that deep drilling does not always confirm theoretical predictions. The reasons for wrong prediction are usually not investigated and, consequently, the same error is often repeated. This, and low productivity of drilling operations with much time wasted on disassembly and reassembly of equipment as geological testing proceeds from one site to another even before one site has been thoroughly searched, explains why it takes up to several years to prepare for actual extraction. It therefore is necessary to abandon the conventional exploration techniques and to introduce

new ones. Geophysical analysis appears to be the answer. Experience in the Ukraine and in Western Siberia has demonstrated the effectiveness of extending computer-aided analysis of geophysical data to the very end of a prospecting operation. With the aid of this technique, not a single empty well has been drilled in the Astrakhan oil region during the past five years. Geophysical support must be built up further, regardless of previously approved exploration plans.
[194-2415]

MARINE AND SHIPBUILDING

MONITORING HARDNESS DURING MACHINING OF HOUSINGS FOR SHIP FITTINGS IN FLEXIBLE MANUFACTURING SYSTEM

BULATOV, V.P., BIRULYA, Ye.V., ZAKHAREVSKIY, A.S., and SIROTIN, I.Yu.

[Abstract] In flexible manufacturing systems for ship fittings housings made of 25L steel, the necessary machining precision is maintained by routine replacement of the cutting tool on the basis of its theoretical life expectancy rather than on the basis of its actual condition. Since hardness of the blanks to be machined is the principal factor determining the tool life, monitoring the hardness of the blanks before machining is proposed as means of ensuring better tool utilization and reliability as well as better machining precision, and also improving productivity by avoidance of untimely tool replacements with attendant loss of time. A statistical analysis of heat treatment and hardness data based on 43 production samples and 172 test specimens has revealed that monitoring all incoming blanks is necessary. It is quite feasible, however, to replace tedious direct mechanical hardness measurements with much easier indirect magnetic ones and, specifically, with measurement of the coercive force. This can be done with an MF-31KTs magnetic structuroscope, in which samples are first magnetized to saturation and then demagnetized. The demagnetizing current, proportional to the coercive force, serves as an indicator of the latter. Curve fitting of test data on samples of 25L steel has yielded a linear relation between demagnetizing current and hardness, for calibration of inspection readings. Figures 4; references 5: 4 Russian, 1 Western (in Russian translation).
[278-2415]

FACILITIES FOR MECHANIZATION AND AUTOMATION OF PRODUCTION

Editorial Staff

[Abstract] Facilities now available for mechanized and automated shipbuilding production include the "Brig-02 A" industrial robot with a vertical drill and

sliding loader, the I3901 cyclic-program-control device with microprocessor for drilling-countersinking machines, the "Vill-500" portable milling tool for stripping holes in fittings made of aluminum alloy, the I1101 photo-electric readout device for continuous data acquisition from 8-track punched tape, "Universal" welding torches for electric welding with nonconsumable electrode under gaseous shield, the "Stapel-100" gamma-ray defectoscope, the "Azimut" automatic equipment with "Elektronika-60" microcomputer for inspection and repair of logic modules, technological equipment for recovery and refining of tin and solder by electrochemical reduction process, a training crane for instruction of crane operators, special clothing (trousers, jacket, helmet) for protection against glass dust and glass fiber, and the 2099 R-5 tensile testing machine for plastics and other materials at normal, low, or high temperatures with "Elektronika DZ-28" computer for automatic data processing. References: 2 Russian.
[278-2415]

COST-EFFECTIVENESS OF ENSURING STABILITY AND UNSINKABILITY OF SHIPS DESIGNATED FOR MODERNIZATION

CHASHKOV, M.T.

[Abstract] The economics of ship modernization and technical decision making are analyzed, with cost effectiveness serving as the sole optimality criterion for comparative evaluation of possible redesign variants. All variants must be soundly based on ship theory and ship mechanics so as to ensure stability and unsinkability. Cost factors taken into account include not only materials and labor but also fuel consumption as principal operating item. The increment of fuel consumption and of attendant operating cost due to stowed solid ballast is most difficult to calculate. It is calculated here for a freighter with such a ballast running empty or carrying a cargo. These calculations are based on applicable formulas and include the admiralty coefficient. Other technical requirements, after stability and unsinkability, must also be included in determining the most cost effective redesign variant, most notably safety, repairability, and convenience. References: 3 Russian.
[278-2415]

CONSTRUCTION

ROBOT WILL ALSO BECOME ERECTOR

GUSEV, V., candidate of technical sciences, docent, Gorkiy Institute of Construction Engineering imeni V.P. Chkalov, Department of Metal Construction

[Abstract] A robot technology is being developed at the Gorkiy Institute of Construction Engineering for erection of structures. All assembly operations have been classified into necessary ones, which will be performed by a robot with universal grippers, 2nd auxiliary, which will be eliminated. Bolted and welded joints need to be redesigned for automatic assembly, with each connection made almost instantaneously by utilization of the weight effect, which also applies to joining walls and floors. The robot, operating in programmed sequence, will not only replace human labor and eliminate accidents but also improve productivity and eliminate costly rigs. Such a technology has already been experimentally implemented in prefabrication of houses, with either hexagonal panels forming a "honeycomb" structure or rectangular pannels joined by tilting and hinging. It may be expedient to replace metal with reinforced concrete as basic material for prefabricated structures. Another promising application of this robot technology is erection of oil derricks, with the aid of a helicopter, already on the drawing board at the Institute. There is great interest in automated assembly by robot throughout the building industry, trailer homes in particular, but inquiries coming to the Institute are still kept confidential pending authorization for disclosure by the USSR State Committee for Construction. [297-2415]

SPECIAL PROPERTIES OF HEAT TREATMENT OF THIN CONCRETE SLABS IN SOLAR MOLDS

ZASEDATELEV, I.B., doctor of technical sciences, professor, SHIFRIN, S.A., candidate of technical sciences, All-Union Scientific Research and Design Institute of Heat Engineering Structures, and TKACHEV, A.V., engineer, Central Moscow Institute of Structural Design

[Abstract] Reinforced-concrete slabs are now widely cured in solar molds under proving-ground conditions, which requires covers made of an optically transparent but thermally insulating material. Such a material is SVITAP, used in the southern regions for curing 100-400 mm thick slabs during 5-6 months of the year cost-free. The lower limit on slab thickness is dictated by the light weight and low thermal capacity of concrete. Thinner slabs could be cured by this method by utilizing additional stored solar energy, converting it into heat, and feeding the latter to the concrete mass. Experiments were performed on 80 mm thick slabs of M 200 concrete (350 kg M 400 Portland cement + 650 kg sand + 1215 kg gravel + 185 kg water per 1 m^3). Their temperature was measured with Chromel-Copel thermocouples and recorded with a KSP-4 instrument for 22 hours, whereupon the slabs were tested for compressive strength with a "Beton-12" ultrasonic device. These experiments were performed in summer and in spring or autumn, with generally 8.5 hours but in some cases also 11 or 13 hours allowed for concreting. The results were favorable, indicating the feasibility of cost-free boosting of the heat storing capacity of thin slabs under a SVITAP cover and thus extending the concretion time to 13 hours. Figures 1; tables 1; references: 2 Russian. [119-2415]

PROBABILITY OF FAILURE-FREE OPERATION OF LINE SEGMENT OF PULP PIPELINE TRUNK

NAMGALADZE, D.P., Georgian Polytechnic Institute

[Abstract] The principal systematic cause of pipeline rupture is fatigue, other major causes such as hydraulic shock and failure of protective devices or defective welded joints and defective pipes being random factors. The probability of rupture and, accordingly, the probability of failure-free operation can be determined on the basis of statistical analysis, which has already revealed that the internal pressure in three pulp pipelines (Noril'sk, Talnakh, Oskol') is a stochastic function of time with a Poisson distribution of time between surges and that the strength of the pipe material under a cyclically varying dynamic load is a stochastic function characterized by a

Gnedenko-Weibull probability density distribution with a form factor $\beta = 2$. Calculation of the probability of rupture during any successive load cycle and, accordingly, the probability of failure-free operation has been programmed in the APL upper-level language for an "Aplixi" computer, assuming equal decrements of fatigue resistance after each pressure surge beyond the permissible limit of 20% above the nominal pressure level. Calculations according to this TD1MAK program have been made for the Noril'sk pulp pipeline with $\lambda = 0.08435$ h^{-1} and $\gamma = 5.74 \cdot 10^{-5}$ cycle^{-1} as well as other pairs of α, γ values in the relation $\sigma_k = \gamma k \theta_s$ (σ - decrement of fatigue resistance, k- consecutive number of load cycle, θ_s- parameter characterizing the strength margin, γ-coefficient). Figures 2; references: 4 Russian.
[132-2415]

DAMS BUILT WITH SOIL MATERIALS RAISED BY DIRECTIONAL BLASTING

NEDRIGA, V.P., doctor of technical sciences, POKROVSKIY, G.I., candidate of technical sciences, and AVDEYEV, F.A., candidate of technical sciences

[Abstract] The method of directional blasting, first used for raising small dikes in industrial sites, has been extended during the past 15-20 years to construction of dams for hydroelectric power plants. Typical examples of their reliable performance are the 72 m high Medeo dam, the 65 m high Baypazin dam in the Bakhsh rayon, the 91 m high dam across a ravine in the Akh-Su rayon, and the 50 m high experimental dam in the Burlykiya rayon. New techniques of mass blasting make it feasible to construct 100-200 m high dams with relative simplicity, without costly preparatory and auxiliary operations such as excavation and transportation. This method is particularly expedient in mountainous regions with rocky soil and river beds of gorge or canyon type with walls sloping not more than 30°, for building a dam deep down with a width-to-height ratio not larger than 2-3. Usually antifiltration shields are needed and are best formed by layerwise pouring of dry coarse-grain soil, preferably within rather than outside the dam structure. Recent studies indicate a possibility of greatly reducing the water permeability of a raised dam by filling rock soil with clay suspension and thus eliminating the need for antifiltration shields. The most interesting project now under way is the dam construction by directional blasting for the Kambaratin hydroelectric power plants, especially for the first unit. The soil here contains granite with alluvial sediment (density 2620 kg/m^3 dry, compressive strength 132 MPa when dry and 123 MPa when saturated with water). Raising the dam will require 219,300 tons of ammonium nitrate, 12,800 tons of diesel fuel, and 28,300 tons of granulite-M for blasting 112,000,000 m^3 of rock mass, with 2.3 kg/m^3 of explosive per 1 m^3 of dam structure. Figures 3; references: 9 Russian.
[131-2415]

EFFECTIVE LIGHT CONCRETES WITH FILLED BINDER

SOLOMATOV, V.I., ARADOVSKIY, Ya.L., and BORISOV, Ye. P., Tashkent Zonal
Scientific Research Design Institute for Standard and Experimental Design
of Residential and Public Buildings

[Abstract] The use of disperse waste limestone fillers in concrete is inves-
tigated. Such fillers are found to make the mixture more workable, and to
reduce the water consumption and water release. The consumption of cement
is reduced which, in turn, reduces sagging and volumetric mass, which
improves the quality of light concrete and makes it more effective. It is
found that complete utilization of waste products from the Almalyksk lime-
stone plant will make it possible to save tens of thousands of tons of
cement, and to reduce the cost of concrete by 2-3 rubles per meter. Tables
1, figures 1, references: 7 Russian.
[225-6900]

WAYS TO INCREASE PRODUCTIVITY OF ROBOTIZED MACHINE-TOOL FACILITY

BELENKO, A.A., engineer

[Abstract] Following the description of a machine-tool facility with hydrau-
lic control of the robot which resets the machine tool for different metal
parts, the performance of such a facility is analyzed with respect to pro-
ductivity. The analysis reveals that the idle time can be decreased and
the productivity thus increased by use of higher-grade oil in the hydraulic
system. This is achievable with a hydrodynamic oil disperser in the system
that operates when the machine tool is idle. Figures 3; references:
2 Russian.
[96-2415]

PREDICTING SHAPE ERRORS OF MACHINED PARTS ON BASIS OF STIFFNESS CHARACTER-
ISTICS OF MACHINE TOOL

SELEZNEVA, V.V., candidate of technical sciences, TARASOV, V.G., graduate
student, and CHERNYANSKIY, P.M., candidate of technical sciences, docent

[Abstract] The possibility of predicting shape errors of a machined part on
the basis of the stiffness characteristics of the machine tool is demon-
strated on the spindle head of model MS 12-250 boring mills. Such a head,
designed as a shaft on two flexible supports, is represented as a series of
elastic elements whose resistances depend on the radial load and inelastic
elements which account for plastic strains and friction. Analysis and
calculations are based on the differential equation of beam theory and
formulas for roller bearings, take into account anisotropy of the radial
stiffness, resulting in dispersion of displacements and instability with

respect to spindle rotation, and make use of design data as well as experimental data. The dependence of the shape error of a hole on this spindle stiffness variation is characterized by a correlation coefficient as high as 0.86 in that particular case. Figures 2; references: 5 Russian.
[96-2415]

CHARACTERISTICS OF COUNTERFLOW SWIRL-JET EJECTOR PUMP

METENIN, V.I., doctor of technical sciences, professor, DENISOV, I.N., candidate of technical sciences, docent, CHERAPANOV, V.B., engineer, and SAMOYLOV, V.Ye., engineer

[Abstract] The feasibility of converting a conical swirl-jet tube with fully closed hot end into a counterflow swirl-jet ejector pump, where the active gas flows in one direction while a mixture of active gas and inert gas flows in the opposite direction, has already been established experimentally. On the basis of the experimental data, the performance of such an ejector pump is analyzed in terms of the pressure-flow characteristic and its dependence on the design geometry in terms of characteristic areas. Calculations are made for such a pump with a circular array of nozzles around an axial diffuser behind a slot diffuser for intake of active gas, a vortical mixing chamber, and a nozzle with deflector for inert gas. The performance of such a pump with compressed air at a temperature of 303 K serving as active gas and, upon rarefaction, ejected into the atmosphere is compared with the performance of conventional DKM swirl-jet vacuum pumps and found to be quite competitive.

Comparison of swirl-jet ejector pumps

Type	Active Gas Pressure, MPa	Active Gas Consumption, kg/hr	Evacuated Volume, m^3	Evacuation Time, minutes	Pressure in Evacuated Volume, kPa	Source
DKM-1	0.294	406	0.04	1.5	0.98	[1]
DKM-1 + DKM-2	0.294	–	0.5	17	2.45	[1]
DKM	0.421	258	self-evacuating	–	2.9	[2]
counter flow swirl-jet	0.26	256	0.003	0.1	0.6	
"	0.2	256	0.12	9	2.0	

1. Dubinskiy, M.G. "Swirl-jet Vaccum Pump" IZVESTIYA AN SSSR, OTN, No 3, 1956.
2. Yepifanova, V.I., et al, "Experimental and Theoretical Study of Swirl-jet Ejector Pumps," IZVESTIYA VUZOV, MASHINOSTROYENIYE, No 11, 1975.
Figures 3; tables 1; references: 5 Russian.
[96-2415]

PRESSURE DEPENDENCE OF SENSITIVITY AND INERTIA OF THERMOELECTRIC OPTICAL-RADIATION DETECTORS

VASILYEV, B.V., Leningrad Institute of Electrical Engineering imeni V.I. Ulyanov (Lenin)

[Abstract] The performance of thermoelectric radiation detectors under increasing gas pressure is evaluated, pressure inside such a device being produced by desorption of gas molecules from the surfaces in a vacuum device or by gas leakage through clearances in a nonhermetic and consequently gas-filled device. The voltage-power sensitivity and the thermal time constant of a nonhermetic radiation detector with separate target and multijunction thermopile are calculated as functions of the gas pressure. The behavior of both quantities is determined by the pressure dependence of the thermal conductivity of the gas. From these relations is determined the limiting pressure, maximum for a vacuum device and minimum for a gas-filled device, at which the sensitivity S remains constant to within a small relative error. On the basis of these theoretical data are established rational design parameters, taking into account environmental factors and their variation with altitude. The pressure characteristics were measured for a thermoelectric radiation receiver with a target consisting of a disk 10 mm in diameter and 30 3.5 mm-long hot chromelcopel junctions around the periphery. The experimental data agree quite closely with the theoretical results. The pressure dependence of the ratio of sensitivity to time constant, this ratio being almost constant over the entire pressure range, is useful for comparing different thermoelectric radiation detectors. Figures 2; references 4: 3 Russian, 1 Western (in Russian translation).
[264-2415]

OPTICAL-INTERFERENCE INSTRUMENT FOR MEASURING FREQUENCY INSTABILITY OF RADIO SIGNAL

GOLOVKOV, A.A. and KUZNETSOV, S.V., Leningrad Institute of Electrical Engineering imeni V.I. Ulyanov (Lenin)

[Abstract] A simple instrument for measuring the frequency instability of radio signals much more accurately than by conventional methods is proposed, namely an instrument which utilizes the interference of diffracted light waves in acoustooptical deflectors. Optical laser radiation from a single

source is run through a beam-splitter and is incident on the two opposed deflectors, which are located at different distances from an interferogram recording device. A shift of the interference pattern is caused by a shift of the sound wave frequency in the deflectors (i.e., a change in the radio signal frequency at the deflector inputs). In this way, the spectrum of a radio signal is transferred into the optical range and measurement of its frequency shift is reduced to counting the number of changes of fringes in the interference pattern within a certain averaging period. Calculation of the attainable accuracy in measurement of transient frequency stability with this instrument, including the errors in each of its components, reveals that the accuracy is determined principally by instability of the optical path and hardly at all by variation of the laser wavelength. Figures 2; references 3: 1 Russian, 2 Western.
[264-2415]

PIEZOELECTRIC MOTOR WITH DIGITAL CONTROL

DZHAGUPOV, R.G. and KUZNETSOV, V.A., Odessa Polytechnic Institute

[Abstract] Piezoelectric motors built with bimorphous elements are used for interference-free and pickup-free transport of magnetic tape, the linear displacement-voltage characteristic of these devices in the subresonance range making them amenable to code control and thus also usable as electromechanical digital-to-analog converters. In such a bimorphous device the inner electrode is grounded and the two outer electrodes are identically subdivided into n segments each. D.c. voltages $V_1,...,V_n$ are correspondingly applied across the segments by switching in accordance with the input code, and the resulting displacement of the free end is proportional to the number of segments under voltage with the proportionality factor depending on the code. The sensitivity of segments increases with their distance from the fixed end. A performance analysis on the basis of these principles reveals that, while making all segments equally long will yield a most efficient device, linearization of the displacement-code characteristic requires unequally long segments in a pattern determined by the code. Other than linear output characteristics can be similarly obtained by appropriately patterning the lengths of segments. Such a device can be controlled by one voltage applied to only one segment and switched over segments through a decoder. It can also be controlled dynamically by a pulse sequence, but then the "memory" of segments must be utilized for switching. Tubular bimorphous elements, most easily manufacturable, have been experimentally found to yield a device with excellent conversion characteristics. Figures 2; references 6 Russian.
[264-2415]

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SPEED REGULATOR FOR BRUSHLESS DIRECT-CURRENT MOTOR

POZHIDAYEV, V.M., OMELCHENKO, V.V., SHUPRUTA, V.V., PUTNIKOV, V.V.,
UVAROV, V.B., and PETROV, Ye.A., Leningrad

[Abstract] A speed regulator for a brushless d.c. motor is described which
does not require a tachometer generator but contains, instead, a rotor
position transducer and an inhibitor in the loop around the commutator.
The inhibitor receives signals from the position transducer and from the
control device in the regulator, but does not pass the transducer signals,
bipolar square pulses, back to the power transistors of the commutator during
a fixed period of time the length of which depends on the magnitude of the
control signal. The switching time of the power transistors is, meanwhile,
inversely proportional to the rotor speed. Variation of the inhibition period
corresponding to variation of the motor output signal is the mechanism which
regulates the rotor speed. An analysis of the time and speed relations,
determined by the electrical and mechanical characteristics of the control
circuit and the motor respectively, as well as experiments with a
DB50-10-4 d.c. series motor and a saturable reactor as inhibitor indicate
the feasibility of speed regulation and stabilization over wide ranges
depending on the load and the permissible speed fluctuation. The speed of a
motor with a ratio of running torque to starting torque equal typically to
0.3 can thus be controlled over a range of 20 or even 40. Figures 3;
references: 3 Russian.
[264-2415]

COMPUTER METHOD OF DETERMINING DEGREE OF STABILITY OF NONLINEAR AUTOMATIC
PULSED SYSTEMS ON BASIS OF INNERS APPROACH

SMOLYAKOV, V.N. and BRIKHARA, V.I., Rostov-na-Donu

[Abstract] Stability of a nonlinear automatic pulsed system consisting of a
linear part and a nonlinear element is considered, an important performance
parameter being the degree of stability which characterizes the decay time
of transients. An algorithm of calculating this parameter is proposed which
involves a change of the variable $z_\gamma = ze^{-\gamma T_0}$ (T_0- discreteness period) in
the criterion of absolute stability and then reduces to stepwise search of
roots of a characteristic real polynomial within a unit circle. Finding
them all within that unit circle ensures that all roots of the characteristic

equation for variable z lie within a circle of radius $e^{-\eta T}0$. This algorithm of the inners method is easily programmable for a computer. Testing of the stability criterion for the linear part and checking the unit circle for roots are done sequentially in the "KACHESTVO" ("quality") program, which allows assigning only one two-dimensional data array in the computer memory for formation of the inners-positive matrices and also allows using the same procedure for double triangulation and for evaluation of the determinants of the respective inners. The transient decay time in a system with a transfer function of the linear part $W_{LP}(z)$ having a fifth-degree polynomial in the denominator was calculated according to this program on a YeS-1022 computer within 17 s. Figures 1; references 4: 2 Russian, 2 Western (1 in Russian translation).
[264-2415]

MATRIX METHOD OF DETERMINING SENSITIVITY FUNCTIONS OF DYNAMIC SYSTEMS

TUSHEV, O.N., Moscow Higher Technical School imeni N.E. Bauman

[Abstract] A method of determining the sensitivity functions of dynamic systems is proposed which differs fundamentally from the conventional integration of ladder equations and uses, instead, series expansions in matrix form. It is demonstrated on a system with piecewise-linear characteristics describable by the equation of dynamics $\dot{X} = \emptyset(A,t)X + F(A,t)$ with $X\big|_{t=0} = X_0(A)$, where $X = (x_1, x_2, \ldots, x_n)$ is the vector of phase coordinates, $A = (a_1, a_2, \ldots, a_s)$ is the vector of system parameters, $\emptyset(A,t)$ is a square matrix of coefficients, $F(A,t)$ is the vector of additive external perturbations, and t is time. Both $\emptyset(A,t)$ and $F(A,t)$ are discontinuous at instants of time t_1 ($l = 1, 2, \ldots$). This equation is transformed into a homogeneous one, by adding the trivial scalar equation $\dot{x}_{n+1} = 0$ with $x_{n+1}\big|_{t=0} = 1$ and combining both into $\dot{X} = G(A,t)X$ with $X\big|_{t=0} = X_0(A)$ and where $G = \begin{vmatrix} \emptyset : F \\ 0 : 0 \end{vmatrix}$. Following expansion of $G = G_0 + \sum_{k=1}^{s} \frac{\partial G}{\partial q_k} q_k$ (t is expanded similarly), the sensitivity functions are calculated with the aid of recurrence relations including one for the jumps at discrete instants of time. The method is extended to nonlinear dynamic systems with piecewise-continuous characteristics, by narrowing the discrete time intervals between jumps down to infinitesimally small ones and establishing a recurrence relation for successive "momentary" jumps in the form of a "momentary" fundamental matrix. Numerical integration can in each case be performed by any simple method such as the Euler method. Figures 1; references: 4 Russian.
[264-2415]

AUTOMATIC INSPECTION SYSTEM WITH ADAPTIVE CHANNEL SWITCHING

ANTONYUK, Ye.M., Leningrad Institute of Electrical Engineering imeni V.I. Ulyanov (Lenin)

[Abstract] The advantage of discrete sequential automatic inspection over continuous automatic inspection is that a single instrument can acquire and process data from several channels. The frequency of inspection depends on the extremal dynamic characteristics of the measured quantities and the problem is to avoid unnecessary redundancy, when parameters of the inspection object have not changed significantly, while not missing unacceptably large deviations of these parameters. Both reliability and economy of discrete inspection are best ensured by adaptive switching of channels. One such system consists of a channel selector, a deviation detector, a storage device for nominal values and maximum permissible deviations, an array of subtractors, and a switch. The selector connects to the detector that channel in which the absolute difference between the inspection signal and the nominal value is largest, whenever this difference exceeds the maximum permissible value. An analysis of the discretization process based on estimating the modulus-maximum of the first derivative of the inspection signal, with the queuing error taken into account, reveals that that adaptive switching results in a much smaller ratio F/f (F- frequency of deviation detector access to subtractor array, f- cutoff frequency in signal spectrum) than in the case of uniform discrete inspection. With adaptive switching, therefore, it is possible to either increase the number of channels or to use a signal spectrum with a higher cutoff frequency, or to do both. Figures 1; references: 6 Russian.
[264-2415]

PROBLEMS IN DESIGN AND ADOPTION OF AUTOMATIC ENERGY MANAGEMENT SYSTEMS FOR PLANTS OF ANY INDUSTRIAL BRANCH

ANCHEVSKIY, I.V., engineer

[Abstract] The need for multifunctional control of energy sources and distributors according to the requirements of any particular technological process is coupled to the need for automatic energy management throughout the branch of industry operating with that technological process. The main problems in designing such an automatic energy management system and adopting it for coverage of all plants of that branch of industry are ensuring necessary designer-user interaction, ensuring adequate engineering and

servicing skills, and follow-through of delivery and installation schedules. The operation of such a system, in accordance with the state of the art, should be based on a central computer with appropriate peripheral equipment including displays and terminal microcomputers subject to inspection. Appropriate selection of analog and digital measuring and recording instruments should optimize the flow of information from individual plants to the dispatcher for remote control. Data processing and control algorithms can be programmed for maximum speed and precision. A closely related problem is cost of the hardware and availability of funds. Figures 2; references 5 Russian.
[111-2415]

METHOD OF DESIGNING SUPERLIGHT-WEIGHT INDUSTRIAL ROBOTS FOR RIGIDITY

KRAVCHENKO, N.F., candidate of technical sciences

[Abstract] A method of designing superlight-weight industrial robots such as the RF-201/202, MP-9S and "Ritm-01" is outlined. The method will ensure the proper rigidity of its manipulator mechanisms, inasmuch as both speed and accuracy of operations are determined by it. Optimal rigidity is defined in terms of the minimal deformation of the end-effector during the entire start-acceleration-deceleration-stop cycle within the prescribed positioning tolerances. The dominant forces acting on the members of a superlight-weight industrial robot are not the inherent weight or the weight of the payloads but the forces of inertia. Taking this and the elasticity characteristics of the manipulator links into consideration, the design procedure is reduced to analytical solution of the applicable general system of equations of motion and subsequent optimization of the solution by the most suitable numerical method. There are three problems successively involved here: 1) determining the rigidity constraint on the manipulator mechanisms consisting of load-bearing members of prescribed dimensions and under given loads; 2) determining the maximal permissible loads under which the necessary precision will still be maintained; 3) determining the optimal elasticity characteristics and the optimal loads under given precision and speed requirements. The first problem is solved by the conventional method according to the theory of beams and resistance of materials, with appropriate extension from static or kinematic to dynamic and correspondingly from steady-state to transient performance. Friction is, for simplicity, assumed to be negligible. Solution of the first problem on the basis of the "two masses" model and subsequent calculations for the next two problems have been programmed for computer-aided design of superlight-weight industrial robots. Figures 7; references: 3 Russian.
[103-2415]

AIRPLANE WING AS MODEL FOR SHEET STACKING OPERATION

ALMEN, I.A., candidate of technical sciences, and IGNATOV, Yu.G., senior scientific associate

[Abstract] Spreading and stacking of aluminum sheets, a manual or mechanical operation not performable with electromagnetic devices, is examined using an airplane wing as model. Analysis and experiments performed at the Belokalitvenskiy Metal Works have led to several inventions facilitating this operation and, most importantly, speeding it up. Since nothing limits the spreading speed, it is the stacking speed which determines the speed of the entire operation. A new mechanical device described in USSR Patent No 454152 makes it possible to reach a stacking speed of 4 m/s - the highest in the world. The concept of using linear motors and no air cushions, as has been proposed for spreading and stacking steel sheets, is not suitable for aluminum sheets because of their instability under a small tangential force and especially due to warping. Aerodynamic spreading and feeding sheets from several spreaders to one stacker, according to USSR Patents No 1013380 and No 1113348, has not only prevailed for aluminum sheets but also been applied to steel sheets. For sheets of nonmagnetic steel, however, manual assistance is still needed for spreading and vacuum devices are needed for stacking. A rarefaction chamber of variable length and width has solved the problem of speeding up the operation in this case, a speed of 2.5 m/s for 1.5-10 mm thick, 1000-2500 mm wide, and 1030-6000 mm long sheets being feasible. The actual cost effectiveness of all these new spreading and stacking devices, amounts to 1.63 million rubles annually, with design modifications appropriate for each specific product item. In a detailed editor's note, the pioneering work in this field done in 1956-1970 by Aleksandr M. Ladyzhenskiy, despite skepticism and negativism in the aircraft industry, is recognized and applauded. Figures 2.
[108-2415]

SIMPLE AND LOW COST FINISHING OPERATIONS

FRAGIN, I., doctor of technical sciences

[Abstract] The honing operation, because of its tremendous advantages, was adopted by the automobile manufacturing industry in the 1920's and subsequently improved to meet requirements for narrower clearances between mating surfaces under higher pressures. In the 1960's, however, the need for simplification and cost reduction led to the replacement of honing by lapping. A lapping tool, with a galvanically deposited nickel plate containing embedded diamond grains, was found to produce a twice-as-precise surface finish in holes at a 5-7 times higher productivity rate than a conventional lapping tool made of cast iron and operating in an abrasive fluid suspension

when used in the manufacture of cast-iron distributor housings for tractors at the Moscow Tractor Hydromatics Manufacturing Plant. Further improvements and developments, with the assistance of Bulgarian specialists in this field, have by 1980 led to replacement of lapping by reaming, an operation requiring only a simple drilling machine and a diamond drill bit. The next step will be combining the use of diamond tools for both cutting and plastic surface deformation. Only lack of interest in innovations by management explains why these new concepts in surface finishing, so readily accepted and proved out by the agricultural machine building industry, have not yet been adopted by other industries. Figures 3.
[108-2415]

TWO-PARAMETER SYSTEM OF ADAPTIVE CONTROL OF A HEAVY MILLING MACHINE DRIVE

MIKHNENOK, E.I., KOZLOVSKIY, N.A., ZAYKIN, M.P. and VOVNEYKO, I.I., Institute of Problems of Reliability and Durability of Machines, Belorussian Academy of Sciences

[Abstract] An adaptive control system has been developed for milling and turning machines at the Minsk Machine Building Production Union imeni The October Revolution. The system is a two-parameter system which regulates the tool based on the speed of rotation of the main drive and feed of the tool. The operation of the system is described in general terms. Experimental studies of a mock-up of the adaptive system were performed on a model 6M610F2-1 milling machine. The tests showed that the adaptive system is an effective means of stabilizing the power and reducing oscillations of milling machine tools. The reduction in oscillations was achieved basically by searching for the optimal speed of the milling cutter, which did not reduce the productivity of metal working. Figures 2; references: 5 Russian.
[68-6508]

USE OF REINFORCED CONCRETE IN CONSTRUCTION OF MACHINES AND EQUIPMENT

VRAILOVSKIY, M.I., Candidate of Technical Sciences, and SHUMAYEV, V.A., Candidate of Economic Sciences

[Abstract] Examples are discussed of the use of reinforced concrete bases and supports as well as reinforced concrete load-bearing elements in the

construction of machines and equipment. Load-bearing elements are used in machines with individual elements and parts which consume large quantities of metal, such as truck dumping platforms. Reinforced concrete is also used to make auxiliary machine elements such as counter weights and balancing weights. The volume of pre-cast reinforced concrete structures for machine building, manufactured in the USSR, has increased from 1,200 m^3 in 1983 to 33,300 m^3 in 1985, allowing a savings of some 50,000 tons of ferrous metals.
[49-6508]

EFFECTIVE NOISE SUPPRESSING FACILITY 'SHUM-1'

MELKUMOV, M.D., candidate of technical sciences

[Abstract] The automatic compressor plant of the Shuman Association enterprises of the ArSSR Ministry of Local Industry was equipped in 1983 with a noise suppressing facility "Shum-1" which consists of an "active" muffling chamber for intake of atmospheric air and a hermetic annex. The "active" chamber also functions as dust precipitator and air conditioner. It is built with GLEN-1M sound absorbing plates. The annex has stone walls with GLEN-1M cladding. The horizontal air suction duct is perforated and has a rough inside surface, with a coarse-grade filter at its inlet for preliminary air cleaning, the exhaust duct also acting as muffler, air cleaner, and ventilator. The vertical air suction ducts have been shortened so as not to protrude beyond the roof and abet contamination of the compressor cylinders. The receiver tanks inside the annex have safety valves and blow-through valves, the suction columns next to them have deflectors at the base which also act as heat and noise sinks. There is a sump for drainage inside the annex. The facility was designed to suppress all noise within the 63-8000 Hz frequency range. It does so very effectively. Figures 1; references: 2 Russian.
[250-2415]

INSPECTION AND CONTROL IN FLEXIBLE MANUFACTURING SYSTEMS

KOLOSOV, V.G., KOROLEV, V.S., TOMASHEVSKIY, A.F., and FEDOTOV, A.I.

[Abstract] Automatic inspection and control in flexible manufacturing systems for product quantities ranging from medium-large lots to single units is analyzed from the standpoint of technological integration, such a system becoming even more effective when supplemented not only with automatic tool

and blank setting but also with computer-aided product research, development, and design as well as automatic evaluation testing. The main problem is in the machining operations, constituting the "hard" segment of such a production system and requiring precise locating and positioning of blanks. Replacement of this segment with a "flexible" one is considered, with approximate locating by an industrial robot with universal fixturing and subsequent precise determination of the actual position with appropriate correction of the machining control program. The problem of coordination can then be reduced to a two-dimensional one and solved at the lower system level. This is demonstrated on a blank with two holes, by analysis of the blank-tool geometry and analysis of the inspection errors. Errors include positional indeterminacy of the gauge as well as static and dynamic measurement errors associated with recording of the time when the gauge makes contact with the part. The static error component can be eliminated by precalibration and the dynamic error component can be reduced by increasing the response speed of the terminal control device. The positioning of a blank can then, moreover, be corrected not only in the terminal control mechanism but also in the host-level computer. Figures 2.
[130-2415]

OPERATIONAL CONTROL OF CASTING PROCESSES IN MACHINE MANUFACTURING PLANT

SARGSYAN, R.A., engineer-economist

[Abstract] The problem of optimum operational control is formulated and solved, by dynamic programming, for a 2-stage process in production of castings in a machine manufacturing plant. Three parameters are controlled here, namely productivity of the process stage, feed rate of raw material to the first stage and product yield rate from the second stage, with minimum casting cost as optimality criterion and a control period of 1 hour as time base. Each stage is to be optimized and the two stages are interlinked. Numerical solution of the system of three equations relating the parameters of both stages is based on statistical data on instrument manufacture in one of the ArSSR production plants and on engineering specifications for the first process stage. The overall optimal variant is found, which in this case does not coincide with the optimal variant when each stage is considered separately. Tables 3.
[250-2415]

IN-PLANT STANDARDIZATION OF MEANS FOR PRODUCTION OF TURBOMACHINERY BLADES

KOTELNIKOV, A.I., candidate of technical sciences, RUBTSOV, Yu.N., candidate of technical sciences, GUREVICH, B.N. and YEGOROV, G.D.

[Abstract] For the purpose of streamlining the manufacture of turbomachinery, the All-Union Correspondence Institute of Machine Design and the Planning Department at the Nevskiy Lenin Plant are developing an industry-wide standardization of all equipment needed for blade production and assembly. This will eliminate variances and discrepancies between blades produced under slightly different conditions in different plants due to circumstances or tradition. First priority has been assigned to layout standardization of machine tools, including column and platens as well as tool heads, also setup and controls. Four standard schemes of positioning, fixturing and clamping a blade for machining operations are considered which involve either the machining surface or the center hole or both. Each scheme has been analyzed for manufacturing precision on the basis of systematic and random errors. The machine tool components are designed as special ones for blade manufacture and as universal ones adjustable to suit various blade shapes and sizes. Figures 4.
[282-2415]

SETTING NORMS IN COMPREHENSIVE STANDARDIZED TESTS OF ROBOT ACCURACY

KOLPASHNIKOV, S.N., and CHELPANOV, I.B., Central Scientific Research Institute of Robotized Technological Systems

[Abstract] All quantities subject to inspection and measurement in standardized certification tests have been classified into three groups: (1) geometrical dimensions of the action zone, (2) technical performance characteristics such as forces, power, temperature rises, vibrations, and noise, (3) specifically robot design and performance characteristics which, measurable by special instruments and procedures, determine the "professional" competence of a robot for a particular job (accuracy of sensors and manipulator responses). In setting norms and standardizing for accuracy tests one ought to first consider those accuracy indicators which are common to all industrial robots, accuracy of positioning and accuracy of displacements in generally six degrees of freedom relative to the robot base as stationary reference. Precise gauges representing objects to be handled by robot grippers are necessary accessories for these tests. The necessity and the possibility of representing an error as the sum of systematic and random components will

depend on many factors indigenous to specific types of robots. In industrial robots with cyclic control, for instance, it is not possible or necessary to determine the systematic error so that, in effect, the random error becomes the total error. In industrial robots with position control, on the other hand, the systematic errors in all degrees of freedom should and can be determined. In industrial robots for flexible production systems, moreover, interchangeability is a key factor and, therefore, each individual robot must be tested not only for systematic errors but also for correct analytical approximation of all their components in generalized coordinates and for their dependence on the manipulator mass. Systematic errors also must and can be determined in technological robots with contour control, this being necessary for checking the accuracy of manipulator trajectories. In all cases it is expedient to classify the total errors into principal ones and additional ones, the former determined under nominal operating conditions and the latter produced by external influencing factors such as differences in weights of objects handled by a multipurpose robot. The aggregate random error is most simply characterized by the mean modulus of the error vector. Figures 2; references: 2 Russian.
[282-2415]

USE OF INTELLIGENT ROBOT FOR EVALUATING QUALITY OF POLISHED METAL SHEETS AND THEIR ASSIGNMENT TO FURTHER PROCESSING IN PRODUCTION OF HEAT EXCHANGERS

ALIYEV, R.A. and TSERKOVNYY, A.E., Sumgait Higher Technical Educational Institution, Azerbaydzhan Institute of Petroleum Chemistry imeni M. Azibekov

[Abstract] Use of intelligent robots in flexible and computer integrated manufacturing systems for production of aluminum heat exchangers is proposed, the function of an intelligent robot being to evaluate the quality of polished sheets and to assign them for further processing. The operation of such a robot is formulated linguistically, using the mathematical apparatus of conditional fuzzy-logic inference. The sensory module supplies seven items of tactile information about two parameters characterizing the state of a sheet upon removal from the tempering furnace, its curvature and temperature. Both parameters, and the corresponding quality indicator, are defined as linguistic variables and as such graded into eleven levels from lowest to highest quality. The decision-making module determines the amount of manipulator-"sorter" rotation necessary to deposit the sheet in the appropriate bin: "nonremovable defect" corresponding to small angle - "retreatment possible" corresponding to medium angle - "next operation" corresponding to large angle. Instantaneous values of the fuzzy quality set and the fuzzy treatment set, both sets having the form $X = \int_{U_X} \mu(u)/u$, are determined with the

"composition rule" according to L. Zade, which is easily programmable for any continuous or discrete robotized production process. Tables 2; references 2: 1 Russian, 1 Western.
[202-2415]

UDC 621.822.722

SOME CAUSES OF FAILURE OF METAL SEPARATORS IN BALL BEARINGS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 2, Feb 86 pp 31-32

BARANOV, I.A., candidate of technical sciences

[Abstract] High-speed ball bearings often fail when operating at high tempera-tures approaching and exceeding 300°C, with the brass or bronze separator falling apart after the steel rivets joining the two half-separator rings have been crushed. One cause of this failure is a thermal tensile stress in the rivets attributable to the difference between the linear thermal expansion coefficients of the rivet material and the separator material. One way to lower this stress in the rivets is countersinking the rivet hole at both ends and insert a spring washer under each rivet head, with a sleeve slipped around the rivet pin acting as both rivet support and radial separator detent. A way to completely eliminate the thermal stress in the rivets is to retain the two separator rings between two slabs of a material with a linear thermal expansion coefficient smaller than that of the rivet material, these slabs nested in undercuts in the separator rings, and drive the rivets through the assembly. The material and necessary thickness of such slabs are determined on the basis of simple strain and stress calculations. Figures 3; references: 1 Russian.
[197-2415]

UDC 621.757:621.865.8

WAYS TO INCREASE COST EFFECTIVENESS OF FLEXIBLE ASSEMBLY LINES IN MACHINE MANUFACTURING

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 85 pp 34-38

SHCHUKIN, V.M., candidate of technical sciences

[Abstract] The cost effectiveness of flexible assembly lines using industrial robots is evaluated and ways to improve it are examined. The main problem is the high cost of industrial robots, the amortization period being often too long, and the even higher cost of auxiliary equipment. This explains the low profitability and therefore slow pace of conversion to robotized machine manufacture. The only way to remedy this obstacle is reducing the unit cost of industrial robots and auxiliary equipment, maximizing the utilization of
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their productivity growth potential, and maximizing their involvement in the assembly process. Cost reduction should be made possible by application of new electronic devices and technologies, and by ganging several industrial robots in one assembly line with a single common control system and set of peripheral equipment. Better utilization and higher productivity depend largely on the design of the assembly process, on maximizing the speed of joining operations and minimizing the idle time between operations. A statistical analysis of the performance of a manipulator is presented as a basic case in point to demonstrate the principle involved. The analysis of the assembly process and subsequent cost analysis indicate that the cost effectiveness of a flexible assembly line will increase as the number of industrial robots or, more precisely, the number of manipulators is increased with attendant optimization of the assembly process and, correspondingly, of the assembly line structure. Figures 7; references: 3 German.
[101-2415]

FEASIBILITY OF USING THERMOVISION SYSTEMS FOR CONTACTLESS INSPECTION OF PRODUCTS MADE BY BEARING INDUSTRY

MALOV, A.N. and PUNDA, D.I., Kuybyshev

[Abstract] Thermovision systems for contactless nondestructive inspection, which yield information about the temperature field in the inspected object and thus also about its internal state, can identify and classify defects that cause wear. The advantage of a thermal image over an optical one is that it reveals danger spots immediately and directly without a need for data interpretation and conversion. An analysis of thermal stresses in a bearing race under cyclic compression as well as cyclic impact by balls yields a relation between temperature rise and defect size as a function of the speed. In bearings designed for 50,000-60,000 rpm nominal speed a thermograph with a temperature resolution of 0.06 K will detect defects even smaller than 10 μm. Two principal kinds of defects are considered. Defects of the first kind, in either outer or inner bearing race, are caused by residual grains of abrasive grinding powder or microchips from a cutting tool, or by solid inclusions in the bearing lubricant. Defects of the second kind, in the outer race, are caused by manufacturing errors and appear either during deformation of the outer race or in the form of scratches on its surface, causing not only wear but also noise. Since the relation between temperature rise, bearing speed, and defect size is different for each kind of defect, a thermograph can distinguish one kind from another when the respective critical size has been reached. Because the true temperature resolution of a thermograph is influenced by a nonuniform emissivity of the object's surface, reliable diagnosis will require additional digital processing of the thermal image. Figures 2; references 10: 9 Russian, 1 Western (in Russian translation). [345-2415]

MODULE FOR IMPROVING CONTROL OF TURRET LATHE MACHINING CENTER

GOYKHMAN, P.A., engineer, DOBROVINSKIY, M.Ye., engineer, UDOVCHENKO, A.B., engineer, and FLANCHIK, B.S., candidate of technical sciences

[Abstract] An NC module (2S85-62-10) based on an "Elektronika-60" micro-computer has been constructed for control of a model OTs KO126F4 turret lathe machining center. Such a center produces parts from sheet metal in a single stand, by piercing to produce holes of various shapes and sizes, notching to form the outline shape of the part, then milling off burrs, and threading holes. It is equipped with a turret which provides two positions for the tool, which is controlled via the main drive to make either 150 or 300 passes per minute. With this basic NC module alone, the program can be interrupted only from the terminal, the timer, or the upper-level host computer, priority depending on closeness to the processor. Adding a special interrupt module makes it possible to handle eight interrupt levels, in accordance with their priority, from components of the machining automation system as well and thus extend the usefulness of the basic 2S85-62-10 module. Figures 1; tables 1.
[125-2415]

SYSTEM FOR AUTOMATIC TEMPERATURE REGULATION IN CASTING MACHINES

BUDINSKIY, V.M., engineer, and KISLITSYN, A.N., engineer

[Abstract] A system for automatic temperature regulation in casting machines has been developed which operates in the proportional pulse-width mode. Its functions are continuous measurement, regulation, and recording of the temperature in each zone as well as indicating with lights and sirens a tem-perature excursion beyond the permissible upper or lower limit, or a break in any thermocouple circuit or heater circuit. Its measurement range is 0-300°C with an error not larger than 2°C, its regulation range is 150-300°C with a static error not larger than $\pm$4°C and a dynamic error not larger than $\pm$6°C. Both light and sound alarms are activated by a temperature within $\pm$10°C of the setting. The regulator draws a power of 150 VA and has a switching capacity of 0.05-12 kW. The system installed in 13 4-zone casting machines at the Pereslavl production plant "Slavich" has improved the quality of castings and saves 49.7 thousand rubles annually. Figures 1; tables 1.
[125-2415]

SYSTEM FOR AUTOMATIC CONTROL OF TECHNOLOGICAL PROCESS IN MANUFACTURE OF PLASTIC PRODUCTS

BONDAR, G.I., engineer, KOLUSHEV, D.N., engineer, and BIKEYEV, Sh.S., candidate of physico-mathematical sciences

[Abstract] A system for automatic control of the technological process in manufacture of plastic products has been developed which should not only improve and stabilize the product quality but also increase the productivity by lowering the reject rate and reducing the down time. It is designed for a plastic reprocessing plant with a stock or raw material, driers, pelletizers, thermoplasticizers, hydraulic presses, and bins for the final product. It provides for operation of manufacturing equipment autonomously without computer, or with computer for inspection and data gathering only, or with full use of computer for data gathering and process control. The computer is an SM-2M machine with two processors and a 128 kbyte direct-access memory. Peripheral equipment includes temperature transducers, three analog-to-digital converters, an input-output device for initiating and discrete signals, interface expanders and matchers, magnetic storage disks, a display, a character synthesizer-printer, and a console for input of production data. In the case of equipment failure or shutdown all data on the state preceding that can be recorded and stored for retrieval in real time. The technical capacity of the system is $2m + 5n$ analog input signals, $6m + 6n$ discrete or initiating input signals, and $6m + 8n$ discrete output signals. Figures 1.
[125-2415]

CONTROL SYSTEM FOR ROBOTIZED PRODUCTION PROCESS OF ROLLING STACKS OF ALUMINUM SHEETS

ALIYEV, R.A., KYAZIMOV, N.M., and AKHMEDOV, M.A., Sumgait Higher Technical School

[Abstract] A microcomputer-based control system for robotized production processes is shown, specifically designed for rolling stacks of aluminum sheets, which involves fast operation of the order of 6-7 s per pass under high impact loads with attendant large vibrations. Auxiliary operations in the process include transportation of blank sheets, stacking them, and

doubling up the front and one of the side edges of a stack. The control
algorithm involves use of a Petri net, most effectively ensuring parallelism
and hierarchism in this cyclical discrete process. The system, based on an
Elektronika-60 micro, processes data, monitors and controls three special
automatic manipulators, a step-motion conveyor, an industrial robot, and a
rolling mill. Such a system has been installed in the Sumgait Aluminum
Evaporator Manufacturing Plant. Figures 2; references: 5 Russian.
[91-2415]

SELECTING OPTIMUM INTERVAL FOR PERIODIC PARTS INSPECTION IN FMS

ZDANOVICH, I.A., LOBUNINA, I.I., and YAKUSHENKO, Ye.A.

[Abstract] Selection of the optimum time interval between periodic inspections
of parts in a flexible manufacturing system is considered for the purpose of
tool adjustment and correction. The problem is treated as one of economics,
taking into account tool characteristics as well as inspection cost and pro-
duction cost. The algorithm of optimization, based on sequences of dimensional
deviations of machined parts from the nominal with and without tool adjustment,
has been for illustration applied to a DF-2 (GDR) NC lathe. The cost
effectiveness of the optimum inspection period has been calculated as a
function of inspection mode and unit manufacturing cost. Figures 3; tables 1;
references: 4 Russian.
[129-2415]

CURRENT ESTIMATION OF TOOL WEAR IN UNMANNED TECHNOLOGY

NEVELSON, M.S., MUSTAFLEV, E.Kh., and REVIS, Ye.I.

[Abstract] Current inspection of machined parts in a flexible manufacturing
system as means of determining the tool wear and timing the tool replacement
is considered as a problem of measurement for process control. Tool wear is
estimated from the dimension of successively finished parts and its devia-
tion from nominal beyond tolerance. The inspection problem is treated as one
of measurement and correction, readings of the gauge being treated as the sum
of wear increments and a random component with zero mathematical expectation
but nonzero dispersion. Theoretical analysis and experimental results have
yielded the optimum model of wear for correctly determining the number of
machined parts per tool cycle. Figures 2; references: 4 Russian.
[129-2415]

STATUS AND OUTLOOK FOR METROLOGICAL MONITORING OF LOW-RADIATION-INTENSITY LASER ENERGY PHOTOMETRY

KOTYUK, A.F. and TIKHOMIROV, S.V.

[Abstract] Procedures and methods are needed for checking instruments which measure 1-10 ns pulses of laser radiation in the 0.5-1.7 μm region of the spectrum at energy levels of $10^{-12} - 10^{-6}$ J and power levels of $10^{-11} - 10^{-5}$ W so as to ensure an accuracy of measurements better than the now feasible 10-15% at low radiation intensity and 30-35% at extra-low radiation intensity, such accuracy being inadequate for modern optical communication and optical radar. It therefore is necessary to extend existing procedures and develop new equipment for this purpose. Thermal methods such as calorimetry are not suitable here. Self-calibration of silicon photodiodes has been found to reduce the error of measurements typically to 0.04% at 0.63 μm at power levels of the order of 10^{-3} W, such accurate measurements in the infrared region also being feasible with self-calibration of photodiodes made of other semiconductor materials and produced by special technologies. Along with these devices and data processing equipment are needed state standards for average radiation power, radiation pulse power, and radiation energy in those low and very-low ranges. Tables 2; references 32: 29 Russian, 3 Western. [129-2415]

TABLE 1

Name and type of instrument Наименование и тип	Application Назначение	operating wavelengths μm Рабочие длины волн, мкм	Energy J Энергия, Дж	Power W Мощность, Вт	Pulse duration, s Длительность импульса, с	Pulse repetition rate, Hz Частота повторения, Гц	ERROR % power по мощности	energy по энергии
Long-distance photometer FUR Фотометр удаляющего расположения ФУР	Measurement of energy density of directional radiation far from source Измерение плотности энергии отдаления направленного излучения на значительном удалении от источника	0.53 0.69 1.06	$10^{-9} - 10^{-4}$ J/cm² Дж/см²	—	$10^{-8} - 1,5 \cdot 10^{-7}$	2000	—	<20
Small-flux photometer FMP Фотометр малых потоков ФМП	Measurement of energy and peak power Измерение энергии и максимальной мощности	0.91 1.06	$10^{-13} - 10^{-9}$	$10^{-6} - 10^{-3}$	$5 \cdot 10^{-8} - 10^{-7}$	<1000	<25	<20
Portable small multifunction photometer for CW and pulsed laser radiation FPM-01 Малогабаритный широкого применения для импульсного и непрерывного лазерного излучения ФПМ-01	Measurement of energy and average power Измерение энергии и средней мощности	0.69; 1.06; 0.485; 0.63	$0,5 \cdot 10^{-1} - 10^{-8}$	$10^{-1} - 10^{-7}$	$0,2 \cdot 10^{-3} - 10^{-2}$ Непрерывное излучение	<1 — —	— — <15	<20 —
" FPM-02 То же, ФПМ-02	Measurement of energy Измерение энергии	0.53; 0.69; 1.06; 0.87—0.91	$10^{-3} - 5 \cdot 10^{-9}$	$10^{-1} - 10^{-7}$	$10^{-8} - 10^{-7}$	—	—	<20
Power meter OM-65 Измеритель мощности ОМ-65 OM-66 ОМ-66	Measurement of average power in optical communication and data transmission systems Измерение средней мощности в ССС и ПП	0.85 ± 0.1 1.3 ± 0.1	— —	$2 \cdot 10^{-3} - 10^{-9}$ $2 \cdot 10^{-3} - 10^{-7}$	Непрерывное излучение То же	— —	<15 <15	— —
Measuring instrument for laser dosimetry ILD-2 Измеритель для лазерной дозиметрии ИЛД-2	Measurement of energy, average and peak power Измерение энергии, мощности	0.53; 0.69; 0.63; 1.06	$10^{-8} - 10^{-1}$ —	— $10^{-6} - 10$	$10^{-8} - 10^{-6}$ $10^{-6} - 10^{-2}$	— —	— $18 - 40$	$18 - 40$ —
Photometer FLN Фотометр ФЛН	Measurement of CW laser radiation power Измерение мощности непрерывного лазерного излучения	0.48; 0.51; 0.63; 0.84; 0.91; 1.15	—	$10^{-9} - 0,3$	—	—	<15	—
Reference photometer FEL-3 Образцовый фотометр ФЭЛ-3	High-precision measurement of energy and checking of on-line measuring facilities Высокоточные измерения энергии и аттестация поверочных средств	0.53; 0.69; 1.06	$10^{-4} - 0.5$	—	$10^{-8} - 2,5 \cdot 10^{-7}$	<1	—	<5
Reference photometer FPL Образцовый фотометр ФПЛ	Measurement of semiconductor laser peak power and checking of off-line measuring devices Измерение максимальной мощности полупроводниковвых лазеров и поверка рсч	0.87—0.93	—	$1 - 10$	$(8-12) \cdot 10^{-7}$	$10 - 7000$	<10	—
Laser power meter IMLI-2 Измеритель мощности лазерного излучения ИМЛИ-2	Measurement of average power Измерение средней мощности	0.4 - 1.1	—	$10^{-5} - 5 \cdot 10^{-2}$	—	—	$15 - 20$	—
Digital laser power meter Elektronika IMLI-3 Цифровой измеритель мощности лазерного излучения «Электроника» ИМЛИ-3	Measurement of average power Измерение средней мощности	0.47—1.1	—	$10^{-5} - 10^{-2}$	—	—	10	—
Optical tester Elektronika OT-6 Оптический тестер «Электроника ОТ-6»	Measurement of power in optical communication and data transmission systems and of attenuation over 60 dB dynamic range with 0.5 dB error Измерение мощности в ССС и ПП и затухания в динамическом диапазоне свыше 60 дБ с погрешностью 0.5 дБ	0.81—0.69	—	$3 \cdot 10^{-9} - 3 \cdot 10^{-3}$	—	—	20	—
Digital optical tester "Elektronika OT-7" Цифровой оптический тестер «Электроника ОТ-7»	Measurement of power in optical communication and data transmission systems attenuation over 30 dB dynamic range with 0.5 dB error Измерение мощности в ССС и ПП и затухания в динамическом диапазоне свыше 30 дБ с погрешностью 0.5 дБ	0.81—0.69	—	$10^{-8} - 10^{-3}$	—	—	30	—

Table 2

Name and type of instrument Наименование и тип	Application Назначение	Operating wavelength μm Рабочая длина волны, мкм	Average power, W Мощность средняя, Вт	Error of power setting, % Погрешность установки мощности, %	Repetition rate (modulation frequency), Hz Частота следования (модуляции) Гц	percentage modulation, % Глубина модуляции %
Combination generator of optical and electric pulses OG5-87	Measurement of parameters of optical communication and data transmission systems, generation of pseudorandom and code pulse sequences of longer than 10-8s duration with rise time and fall time shorter than 5·10-9	0.85 ± 0.03; 1.3 ± 0.1	$10^{-4} - 10^{-3}$	20	$5 \cdot 10^7$	> 70
Generator of optical signals OG4-162	Generation of optical sinusoidal signals with external modulation	$0,87 \pm 0,07$	$\geqslant 10^{-5}$	20	$20 - 10^7$	$10-85$
Generator of optical signals OG4-163	Generation of optical sinusoidal signals with external modulation	1.3 ± 0.1	$> 2 \cdot 10^{-6}$	20	$20 - 10^7$	$10-85$

FINISHING OF TOOTHED WHEELS BASED ON SYNTHESIZING TWO-PARAMETER SURFACE MESHING

ZAMORUYEV, G.B. and KOCHEGAROV, B. Ye.

[Abstract] A finishing tool is synthezized for use with conical and hypoid
gear wheels as the most general case of synthesizing two-parameter meshing of
surfaces, providing a reliable, universal finishing method that is suitable
for broad practical application. A system of equations is derived that yields
the parameters of the tool and adjustment of the machine for reproducing an
actual tool in the form of a shaver, honing head, or lapping tool that exhibits
the parameters and finishing capability of the corresponding "ideal tool".
References: 3 Russian.
[249-6900]

OPTIMIZATION OF STRUCTURAL DESIGN AND OPERATING CONDITIONS OF CYLINDER SEALS OF HIGH PRESSURE ETHYLENE COMPRESSORS

ZAVOYKO, A.M., candidate of technical sciences, DANILOV, I.S. and SMIRNOV, B.Ye., engineers

[Abstract] Lubrication and wear constraints on the seals of second stage ethylene compressors require the use of two types of cylinder seals: 1) Piston types capable of operating at pressures up to 150-160 MPa, above which their service life falls off sharply, and 2) stuffing box seals for pressures of 250 MPa and higher in the first and second stages. The latter type significantly improves lubrication of the friction pairs of the seals, since the lubricant is delivered directly to the friction points. The improved lubrication enhances both reliability and service life. Two variants of stuffing box cylinder push-rods are manufactured: 1) for pressures up to 150 MPa (stage I) using steel with the working surface plated with a hard alloy, and 2) those for 250 MPa and up made entirely of a hard alloy. The service life of the latter seals at pressures to 250 MPa with nominal lubrication runs from 7,000 to 15,000 hours. This paper also briefly covers various types of lubricating oils and additives: those for large compressor systems with stuffing box seals in all stages use polyglycol oil additive in amounts of 0.02 to 0.04% to produce polyethylene meeting all Soviet and world standards for the commercial product. Polyglycol use requires the addition of oxidation inhibitors to the polyethylene. A simple empirical formula is given for calculating the lubricant feed to each lubrication point in ultrahigh pressure ethylene compressors. References 3: 1 Russian, 2 Western.
[277-8225]

AUTOMOBILE ENGINE FOR OPERATION WITH HIGH-HEAD GAS-JET EJECTOR

SHKRET, L.Ya., candidate of technical sciences

[Abstract] The performance of a ZMZ-53, V-8 automobile engine operating with
a high-head gas-jet ejector in an ATs-5M2 tank truck was measured in a KI-5524
electronic test stand. Each of the two groups of cylinders 1-4-6-7 and 2-3-5-8
was cut off alternately, by passage of atmospheric air into the throttle
space of the corresponding mixing chamber of the carburetor. This, according
to the results, improved the engine performance in terms of fuel economy as
well as speed-pressure and temperature characteristics at a fixed pressure
of exhaust gases within the 0.21-0.20 MPa range, without degrading the ejector
performance. This is attributable to more efficient and more complete burning
of gasoline in the other group of cylinders. The attendant reduction of the
operating speed contributes to an overall improvement of performance. The
effect of cylinder cutoff can be optimized by adjustment of the firing angle.
Further improvements are attainable by more effective utilization of the heat
of combustion products, usually exhausting at temperatures above 500°C, namely
by partial insulation of the exhaust system and by injection of water to be
vaporized. The fuel consumption depends on the ratio of water injection rate
to fuel injection rate and is minimum within the 2-2.5 range of that ratio.
Figures 2; references: 7 Russian.
[96-2415]

ENERGY LOSSES IN RUNNER OF WATER TURBINE

VARLAMOV, A.A., candidate of technical sciences

[Abstract] Simple relations are established for the three components of energy
loss in runners of water turbines, namely profile drag loss, blade tip loss,
and additional impact loss. The formulas for the respective loss coefficients
are based on average values of hydrodynamic parameters and are referred to a
runner wheel 1 m in diameter under a pressure head of 1 m. The numerical
ranges of two form factors characterizing the vortex trail geometry and the
circulation pattern respectively refer to PL548 runners. The three losses are
in general not linearly additive functions of the circulation factor. The im-
pact loss is minimal at a zero change of momentum and the blade tip loss is
minimal at the smallest circulation gradient. With these three loss coeffi-
cients the runner efficiency can be calculated for any width of clearance
between runner blade and draft tube. This calculation is made by the method
of elementary runners into which the spane of a blade from root to tip is hypo-
thetically subdivided. Figures 3; references 8: 6 Russian, 2 Western (in
Russian translation).
[111-2415]

LENINGRAD MANUFACTURER TO SUPPLY 150 MW GAS TURBINES

Moscow TASS in English 1622 GMT 28 Feb 86

[Text] Leningrad February 28 TASS--150 megawatt gas turbines now manufactured at the association "Leningradsky Metallichesky Zavod", are intended to sharply increase electricity supply during peak-load periods.

It takes a little more than a half-hour to set them working at full capacity. The production of the machines has been envisaged by the guidelines of the USSR's Economic and Social Development, submitted for consideration to the 27th Congress of the Communist Party of the Soviet Union.

The essential growth of power available per worker in Soviet industry and agriculture, and the increase in the number of electric household appliances owned by the population have substantially destabilized daily power consumption, Igor Bodrov, the chief designer of the turbines, said to a TASS correspondent. Current peak-load requirements exceed by one-third the average level, which calls for powerful standby facilities at electric power plants.

In order to equalize generation and consumption of power, the Soviet Union is implementing a program of building hydroelectric pumped storage power plants and quick-action gas machines. The latter cost relatively little to manufacture and have the advantage of using natural gas, the production of which is to grow sharply in the country.

Unlike the previous 100 megawatt gas turbines, the new machines feature lower specific metal consumption and higher efficiency.

/9716
CSO: 1861/228

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ROTATION OF SOLID BODY IN MAGNETIC FIELD

KOZLOV, V.V., Moscow

[Abstract] The equations of motion for a solid ferromagnetic body in a constant uniform magnetic field are formulated as Euler-Poisson equations, taking into account the Barnett magnetization effect along the axis of rotation when the magnetic moment of the body is in the same direction as the angular velocity vector. Upon application of the variational principle to the corresponding Poincare equations, which in Hamiltonian form become identical to Kirchhoff equations on four-dimensional manifolds, their complete integrability requiring a fourth independent integral is examined and found to require dynamic symmetry of the body. In the asymmetric case integrability implies splitting the separatrices of rotations of a free solid body about its mean axis of rotation in the presence of gyroscopic forces. The existence of periodic solutions is examined first generally by the methods of variational calculus in the large with appropriate factorization, and then by perturbation of the Euler-Poisson equations. In the general case, complete integrability requires two independent integrals, and a new case where two supplementary independent ones (not just one as in many cases) exist is demonstrated. References 16: 10 Russian, 6 Western (4 in Russian translation).
[80-2415]

NONLINEAR INTEGRO-DIFFERENTIAL EQUATIONS FOR AEROELASTICITY

ASTAPOV, I.S., BELOTSERKOVSKIY, A.S., and MOROZOV, V.I., Moscow

[Abstract] The flight of an elastic aircraft through the atmosphere is described by a system of equations in an inertial system of rectangular

coordinates stationary relative to earth, assuming that in the undeformed state this aircraft has a vertical plane of symmetry. The aircraft carries an array of loads rigidly attached to it and each assumed to have its mass concentrated at one point. The aircraft is subject to aerodynamic forces as well as to the force of thrust and the force of gravity. From the equations of motion are derived equations of aeroelasticity which account for variation of altitude and form a closed system. The motion of the aircraft is thus regarded as a three-dimensional one, with assumed steady-state streamlining and constant kinematic parameters including the angle of attack and the glide angle. On this basis is derived a system of Volterra integro-differential equations describing perturbed motion of the aircraft. This system is linearized and its Cauchy matrix is used for stability analysis. Upon replacement of the kernel with simpler functions according to the method of group approximation of transient-response functions and so as to facilitate a Laplace transformation of those equations, the condition for stability of perturbed motion is established in the form of an inequality and its validity is proved as a theorem. The nonlinear integro-differential equations of motion have been solved numerically for a hypothetical transport plane struck by a vertical gust at a velocity of 30 m/s while flying at a velocity of 150 m/s at an altitude of 1000 m. Figures 3; references 7: 4 Russian, 3 Western (1 in Russian translation).
[80-2415]

MOTION OF GYROSCOPE WITH LOW SELF-EXCITATION

PIVOVAROV, M.L., Moscow

[Abstract] A self-excited gyroscope and the evolution of its rotational motion are considered, assuming a low self-excitation energy and a high kinetic energy of rotation. To the two moments acting on it in the unperturbed state, driving moment and resisting moment, is added a perturbing moment containing not only quadratic dissipative components but also dissipative components linearly dependent on the angular velocity. The phase portraits of the analytical solutions to the equations of motion are constructed and the equilibrium positions are identified on them, these portraits being identical to those constructed by numerical integration of the equations of motion. Figures 4; references 10: 5 Russian, 5 Western (1 in Russian translation).
[80-2415]

ACCELERATION OF CONTACTLESS GYROSCOPE IN RESISTANT MEDIUM

KUDIN, S.F. and MARTYNENKO, Yu.G., Moscow

[Abstract] A gyroscope in contactless suspension is considered, its wheel
being a dynamically symmetric solid body whose angular motion relative to its
center of mass does not depend on the linear motion of the latter. Accelera-
tion of such a wheel in a resistant medium, just as of the rotor of an induc-
tion motor, continues till the drag torque becomes equal to the driving torque.
The wheel is assumed to accelerate in a uniform magnetic field rotating in the
same direction about the same axis. The material of the wheel is assumed to
have unity magnetic permeability and the penetration depth of the magnetic
field in the conductors of the winding which produces this field is assumed to
be much larger than the wheel dimensions. The closed system of two equations
describing the acceleration yields a frequency equation and from that equation
is derived a system of three equations of perturbations. The solution of the
latter is analyzed for stability of small linear oscillations about the equa-
torial axis of the gyroscope wheel. The conditions for stability established
on this basis are particularized for a gyroscope wheel with a spherical sur-
face. Figures 3; references: 6 Russian.
[80-2415]

INTEGRATION OF EQUATIONS OF MOTION OF GYROCOMPASS

BASHIROV, R.Kh., Moscow

[Abstract] A gyrocompass is considered which consists of a gyro in gimbals
with the center of mass offset from the pivot point. This gyrocompass is
mounted vertically on a platform stationary relative to earth, earth being
assumed to have a spherical shape. All components of this device are per-
fectly solid bodies rotating in ideal frictionless bearings, their axes of
rotation intersecting all at one point. The axes of both gimbals and the
wheel coincide with the respective axes of inertia. The motion of such a
gyrocompass within a defined geographical trihedron is described by a system
of nonlinear equations in the Hamiltonian form. Only the periodic solutions
are considered further, and specifically the class of solutions corresponding
to small-amplitude nutations. These equations and perturbations relative to the
equations for a free gyro become integrable in the first approximation with
respect to the Hamiltonian $K_0 + \varepsilon^2 K_1$ in action-angle variables. Two theorems
are stated and proved regarding the integrals of that two-frequency system of

equations. The period of conditionally periodic evolutionary motion is then obtained in terms of complete elliptic Legendre integrals of the third kind with complex parameters and with the modular angle as argument. Finiteness of the two angles of rotation involved here allows a simplification, namely reduction to a single complete elliptic Legendre integral of the first kind. Figures 6; references 8: 7 Russian, 1 Western (in Russian translation). [80-2415]

HIGH ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

UDC 536.24

RADIATIVE, COMPLEX HEAT TRANSFER IN SYSTEM OF MEDIA WITH DIFFERENT INDICES OF REFRACTION (1. RADIATIVE HEAT TRANSFER IN PLANE TWO-LAYER MEDIUM WITH DIFFERENT OPTICAL PROPERTIES)

[Synopsis of article by L.I. Dagis, L.S. Segalovivius, and M.M. Tamonis, pp 76-86]

[Text] A solution is investigated of the equation for radiation intensity for an infinite, plane-parallel, two-layer medium, bounded by opaque walls with both diffuse and specular reflection in a fundamental statement of the problem. Detailed allowance was made for the selectivity of the optical properties of the media and the confining walls. Terms are given for local radiant heat flows in any of the media. Integration over layer thickness was carried out analytically by piecewise approximation of the values of the radiant flow, and over beam angle it was carried out numerically by the Gauss method. The proposed method of calculation was used to calculate the values of radiant heat flow in systems consisting of a semi-transparent gray medium, a vacuum gap, and water-and-steam. It was shown that the magnitudes of radiant heat flow are related to whether the reflecting walls are diffuse or specular, with changes in the degree of their blackness. For the gray medium calculations were performed for a wide range of values of Bu. For the water-steam system it was shown that the thickness of the water layer has a substantial effect on the value of a thermal radiant flow for various values of the degree of blackness of the confining walls. Four illustrations, and eight references.

12697/9716
CSO: 1861/265

DESIGN AND OPTIMIZATION OF PARAMETERS OF WIGGLER MAGNET FOR FREE ELECTRON
LASER

FIKS, A.Sh.

[Abstract] The spatially varying magnetic field required in free electron
lasers in order to make the electron beam "wiggle" can be produced by a
wiggler magnet system in the form of a periodic set of solenoids with bifilar
windings so that the current flows in opposite directions in adjacent solenoids.
This paper analyzes a physical model of such a magnet system making the
following assumptions. The solenoids have a rectangular cross-section; the
axis of symmetry of this section coincides with the direction of the electron
beam; and the solenoid current density is constant over the solenoid cross-
section. The longitudinal current is disregarded and the solenoid system is
infinite with a strictly regular period and there are an arbitrary number of
turns on an individual solenoid. Partial differential equations are written
and solved in order to derive expressions for the magnetic field and induc-
tance of the wiggler system and the wiggler geometry is optimized for a speci-
fied field at the surface occupied by the electron beam for two limiting cases:
a short field pulse produced by a capacitor discharge across the wiggler mag-
net, for the purpose of minimizing the energy of the storage power supply and
in the case of continuous operation for the purpose of minimizing power con-
sumption. While the equations presented enable engineering calculations of the
relevant design and optimization parameters, no sample calculations or experi-
mental checks are adduced. Figures 2; references 7: 4 Russian, 1 Western,
2 Western in Russian translation.
[347-8225]

IDENTIFICATION OF ASSIGNED HEAT CONDITIONS OF A STRUCTURE BASED ON EXPERI-
MENTAL DATA OBTAINED UNDER OTHER CONDITIONS

BALASHOVA, I.Ye.

[Abstract] The problem of determining the temperature within an object based
on temperature data obtained during experiments using different heating condi-
tions is quite important. The method based on utilization of a so-called
"reference" set of conditions and conversion factors calculated from experi-
mental temperature information at an assigned point in a structure by analytic
solution of a one-dimensional heat conductivity equation has limitations in
its application. Another model suggested is the equation of heat conductivity
for a smaller number of layers of the same geometry with a certain constant
effective heat conductivity factor for each layer, using an abstract mathe-
matical model suggested in this article. Identification of the thermal condi-
tions of an actual structure at a given point is performed by calculating the
effective heat conductivity coefficient which provides the required thermal
conditions at that point. The effective heat conductivity is determined by
solving this inverse heat conductivity problem by an iterative method,
minimizing a functional presented in the article. Figures 3, references:
5 Russian.
[269-6508]

STRUCTURE OF LASER RADIATION ABSORPTION WAVE DURING THERMAL DISSOCIATION OF
TRANSPARENT CONDENSED MEDIUM

POPOV, S.P. and FEDOROV, G.M., Scientific Research Institute of Nuclear
Physics, Moscow State University imeni M.V. Lomonosov

[Abstract] A previous series of studies determined the experimental charac-
teristics of absorption waves in multicomponent silicate glasses for incident
laser radiation intensities of 10^6-10^7 W/cm^2, in which the approximation of
geometric optics can be used. A numerical solution of a system of equations
for temperature and optical radiation flux density with nonlinear source terms
is used to study the motion of the absorption and dissocation waves in the
volume of the glass. Calculated data agree satisfactorily with experimental
data for silicate glass. The recombination rate constant is about $1 \cdot 10^5 s^{-1}$,
at which point the characteristic width of the temperature surge behind the
leading edge of the wave is about 10 μs or less. In the experiment, the

surface layer of the optical discharge is attenuated in less than 10 μs. The temperature of the interior plateau region is practically independent of the intensity of the incident radiation in both calculation and experiment. The characteristic layer thickness calculated, 15-25 μm, agrees satisfactorily with the experimental thickness of 30 μm. The overall contour of the absorption wave agrees well with the experimental form of the "head" portion of the optical discharge. Figures 2, references 8: 7 Russian, 1 Western. [269-6508]

DETERMINATION OF CORRELATIONS INVOLVING FLUCTUATIONS OF ELECTRICAL PARAMETERS DURING TURBULENT MHD FLOW

VATAZHIN, A.B. and LEVITAN, Yu.S., Moscow

[Abstract] The set of correlations characterizing a turbulent MHD flow is determined, for construction of a consistent theoretical and design model of such a flow. Considering that the magnetic Reynolds number is usually much smaller than unity, and disregarding all but second-order correlations in the case of uniform electrical conductivity, only correlations $<E'^2>$, $<v' \cdot E'>$, $<v' x E'>$ involving fluctuations E' of the electric field intensity and fluctuations v' of the velocity in the equations of such a flow need to be evaluated. This is done for uniform isotropic turbulence, in a homogeneous isotropic electrically conducting incompressible fluid generally and then in a liquid metal specifically. On this basis, and taking into account Joule-effect heat generation, are also calculated the MHD power and the work of the fluctuation force along the path of velocity fluctuations. The results reveal that the electric field is anisotropic, even though the force field is isotropic. References: 3 Russian. [95-2415]

CORRECTIBILITY OF OPTICAL SYSTEM BUILT ON BASIS OF COMPUTER-AIDED DESIGN USING SURFACES AND ELEMENTS WITH GIVEN PROPERTIES

BUTSEVITSKIY, A.V. and VOZNESENSKIY, N.B., Department of Optical Devices Theory, Leningrad Institute of Precision Mechanics and Optics

[Abstract] A computer program has been developed at the Leningrad Institute of Precision Mechanics and Optics for designing an optical system with

surfaces and elements whose properties are given, where monochromatic aber-
rations of the axial aperture ray and principal object ray remain within
tolerances. Two methods of further correction are proposed, neither of them
requiring calculations for additional rays. The first method utilizes third-
order aberrations. Assuming that there are no aberrations higher than fifth-
order, correction is achieved over aperture and field of view by simultane-
ously minimizing the aberrations of both aforementioned rays and the Seidel
aberrations. This method requires weighting the components of the estimator.
The second method is minimizing the wave aberration or, more precisely, its
mean square over aperture and field. This method, based on an objective
quality criterion, does not require weighting an estimator. Both methods are
demonstrated on precorrection of a GR-10A hydromatic objective designed with
all surfaces isoplanate relative to the principal ray of the field edge. The
first method is preferable for correcting large initial aberrations, when
weighting third-order aberrations improves the optimization process. The
second method is preferable for correcting small initial aberrations, when
balancing each aberration in the field and the corresponding aberration in the
aperture can be done. Figures 4; tables 1; references 2: 1 Russian, 1 Western.
[348-2415]

COMPUTER-AIDED DESIGN OF OPTICAL SYSTEMS BY METHOD OF PSEUDORAY TRACING

IVANOV, A.V., Department of Optical Devices Theory, Leningrad Institute of
Precision Mechanics and Optics

[Abstract] For a computer-aided design of optical systems with most economi-
cal use of machine time, new formulas for the coefficients of transverse
higher-order aberrations are proposed, simpler and more compact than those now
used for synthesis, by the method of pseudoray tracing. The coordinates of a
"true" ray are expanded into power series and all elementary functions of the
latter are expanded into Maclaurin series with respect to coordinates of the
"null" ray. The "pseudorays" refer to the partial summing of higher terms
of the series solution, i.e., higher orders of aberration are taken into
account. Calculating the fifth-order aberration requires 49 addition and 59
multiplication operations, 91 and 111 for seventh-order and 146 and 179 for
ninth-order. Explicit interpolation to find the location of the "true" ray
requires many pseudorays, much more accurate and economical being interpola-
tion based on a rational selection of basis pseudorays and of a calculation
sequence. Only sagittal and oblique pseudorays are used, since the sagittal
component of meridional pseudorays is zero and, therefore, meridional pseudo-
rays are not helpful. The interpolation matrix for pseudoray tracing can be
partitioned so that some submatrices will be filled with zeros and the highest
dimension of the system of equations for the aberration coefficients will
decrease: to four for the coefficients of seventh-order aberrations and to five

for ninth-order. For the coefficients of fifth-order and third-order transverse
aberrations they are already low. References 9: 4 Russian, 5 Western.
[348-2415]

OPTICAL SYSTEMS FOR FOCUSING MONOCHROMATIC RADIATION

ANDREYEV, L.N., ANDREYEV, V.P. and NIKIFOROVA, G.L., Department of Optical
Devices, Leningrad Institute of Precision Mechanics and Optics

[Abstract] Several optical systems for focusing monochromatic radiation are
evaluated, including the feasibility of operating the same objective at two or
more discrete wavelengths. In some applications such as manufacturing pro-
cesses, for instance, the object is observed with visible light at one wave-
length most appropriate for a sharp contrast and is treated with radiation at
another wavelength in an invisible region of the spectrum. When two independent
channels are available, then each one can include a monochromatic objective
designed for its particular wavelengths. When both observation and treatment
are combined in one channel, however, then switching the common objective from
one wavelength to another requires also a refocusing. Using only positive
optics so as to avoid spherical and chromatic aberration is not desirable,
because then the object cannot be visually monitored during its treatment. This
becomes possible, however, with an objective achromatized over the spectral
band which extends between the two wavelengths. Such an objective will consist
of compound optics and a chromatic or hyperchromatic afocal aberration compen-
sator. The principle can be extended to switching an astronomical objective
from one spectral band to another by means of a corrective lens. For a compara-
tive evaluation of these various schemes, aberrations at wavelengths $\lambda_1 = 0.8$ μm
and $\lambda_2 = 0.6328$ μm have been calculated for a monochromatic objective along
and with a correcting lens or with a hyperchromatic compensating lens. Figures
1; tables 3; references: 7 Russian.
[248-2415]

DIRECT AND RESONANT FISSION OF NUCLEI BY MEDIUM-ENERGY HADRONS (DOPPLER EFFECT)

BALASHOV, V.V., DOLINOV, V.K., KOROTKIKH, V.L. and LANSKOY, D.Ye.

[Abstract] The problem of splitting nuclei by medium-energy particles is considered, experiments with coincidence of scattered particle and knocked-out particle having so far been most informative about this process. Other variants of a correlational experiment are examined, particularly measurement of the Doppler line of gamma radiation emitted by an excited daughter nucleus and recorded simultaneously with a scattered particle. A nucleus-target A is assumed to be split by a particle τ in a b+ B*(Jπ) channel. If the life of state B* is shorter than the nucleus stopping time in the target material, then all changes in the distribution of knocked-out particles or, more precisely, in the form of the angular correlation between scattered particle and knocked-out particle are manifested in corresponding changes of the form of the Doppler line which represents the γ-transition B*(Jπ) $\rightarrow$ γ + B(J'π') in the daughter nucleus. On the basis of the properties of such a Doppler line, particularly its symmetry characteristics and sensitive dependence of its asymmetry on the angular distribution of nuclear fission products, it is demonstrated with the π^++ ^{16}O $\rightarrow$ π^++ p+ ^{15}N*(3/2-; 6.33 MeV) reaction following

$$\rightarrow ^{15}N_{gs}+\gamma$$
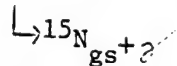
bombardment by a 2 GeV/s pion that Doppler lines can be useful tools for determining the relations between direct and resonant nuclear fission. Figures 3; references 11: 5 Russian, 6 Western.
[268-2415]

NONEQUILIBRIUM LUMINESCENCE OF GLASS HEATED BY LASER BEAM

KASK, N.Ye., LEKSINA, Ye.G., FEDOROV, G.M. and YABOROV, M.T.

[Abstract] Laser heating of transparent dielectric materials has been found to result in nondirectional luminescence with an intricate spectrum and Planck intensity distribution, plasma glow in the region of optical breakdown being generally associated with thermal equilibrium in the 3000-10,000 K range of effective temperature. Detection of a nonequilibrium component is made difficult by gas dynamic dispersal of the breakdown plasma. In an experimental study such a component was found to exist in the luminescence of transparent glasses optically broken down by laser radiation. Glasses capable of sustaining

optical discharge, the quasi-steady stage of optical breakdown, were selected for the experiment with a neodymium laser emitting pulses of 10 ms duration in the quasi-CW mode. Plasma glow was confined by means of interference filters within narrow spectral bands and was recorded by a photomultiplier. Data were processed via a CAMAC system after analog-to-digital conversion of photomultiplier output signals. Conversion time was 3 μs, data packaged into 16-bit words were read into the computer memory at a rate of 125 kHz. Interpretation of the results and theoretical analysis, assuming that glow of hot plasma is attenuated by a neutral absorbing surface layer, indicate that recombination of active particles produced by photolysis of glass plays an appreciable role in the phenomenon. The existence of such a nonequilibrium luminescence component is confirmed by its hyperbolic decay in K8 glass after laser action has ceased, unlike the exponential decay in ZhS12 glass, and also by its dependence on the concentration of quenching impurity. Increasing the iron ion content from 0.1% to 0.7% was found to monotonically lower the effective color temperature during laser action without changing it during the thermal stage of subsequent decay after laser action. Figures 5; references: 19 Russian. [268-2415]

PROTON OPTICAL POTENTIAL OF ^{53}Cr AT LOW AND INTERMEDIATE ENERGY LEVELS

ROMANOVSKIY, Ye.A.

[Abstract] For development of a microscopic theory of the optical potential and for describing the interaction of heavy ions with atomic nuclei, experimental data have been obtained on scattering and polarization of low-energy and medium-energy protons by ^{53}Cr nuclei. These data pertaining to differential cross-sections for polarization and elastic scattering, and integral cross-sections for reactions, are checked against calculations of four parameters V_R, W_D, r_D, α_D of the optical model with parameters V_{sO}, r_{sO}, α_{sO}, r_0, α_0 fixed. The results confirm the validity of this optical model, with the magnitude of W_D determined from the relations $J_D/AA_1 = J_D(W_D)/AA_1$ and those of all other parameters according to F.D. Becchetti-G.W. Greenlees (PHYSICS REVIEW Vol 182, 1969). The parameters according to S. Kailas (PHYSICS REVIEW C20, 1979) do not fit here. Figures 5; references 27: 8 Russian, 19 Western. [268-2415]

NEW METHODS OF CONTROLLING RADIATION OF SOLID-STATE CW LASERS BY MEANS OF NONLINEAR OPTICAL EFFECTS

KIRYANOV, A.V., KORNIYENKO, L.S., KRAVTSOV, N.V., NANIY, O.Ye., PASHININA, N.P., SIDOROV, V.A., SUSOV, A.M., SHELAYEV, A.N. and YATSENKO, Yu.P.

[Abstract] For the purpose of controlling the radiation and the performance characteristics of solid-state CW lasers, an experimental study was made with a YAG:Nd^{3+} laser of combining the effects of nonlinear absorption, frequency conversion and active medium amplification. Mode locking in a linear laser was achieved by means of a passive nonlinearly-absorbing filter as well as kinematically by low-frequency periodic varying of the resonator length. The filter was an organic dye (No. 3274u) solution in ethyl alcohol or an LiF crystal with F_2-centers after exposure to gamma radiation. A nonlinear crystal, $LiIO_3$ or $LiNbO_3$, was also in the resonator cavity for frequency doubling. The effects of these devices combined with the effect of nonlinear amplification in the active medium. The results of measurements during free lasing and ultra-short-pulse trains indicate ways to optimize the laser CW performance characteristics. It was found that a nonlinear frequency converter widens the range of either type of mode locking, but that in a ring laser any of these nonlinear devices (particularly a non-resonant saturable filter with F_2-centers) tends to weaken the concurrence of counterrunning waves. Figures 5; references 12: 11 Russian, 1 Western.
[268-2415]

THE ZHIRAK-0 PLASMA SYNCHROTRON

ANDREYEV, V.V. and GOLOVANIVSKIY, K.S., University of International Friendship imeni P. Lumumba

[Abstract] A description is presented of the principle and design of the Zhirak-0 plasma synchrotron, which was manufactured as a physical demonstration of the phenomenon of gyromagnetic autoresonance. The effect of gyromagnetic autoresonance is that the cyclotron resonance in a rarefied plasma is automatically maintained with a magnetic field smoothly increasing over time. The relativistic mass of particles participating in the resonant interaction increases quasisynchronously with the growing magnetic field. Using the phenomenon of gyromagnetic autoresonance, the plasma synchrotron heats plasma to relativistic temperatures. Stable plasma formations have been obtained with relativistic electron temperature and densities of up to 10^7-10^8/cm^3 with a

characteristic decay time on the order of 10 ms. Hard x-radiation from the plasma clusters obtained in the synchrotron is recorded for about 35 ms. Figures 5; references: 2 Western.
[62-6508]

MODES OF HURLING SOLID PROJECTILES OF LOW-(ELECTRICAL) CONDUCTIVITY MATERIAL IN RAILOTRON ACCELERATORS

KALIKHMAN, S.A. and TAVRIN, V.Yu.

[Abstract] The performance of a railotron accelerator with and without a magnetizer for experimental study of high-velocity impact of solid bodies against a barrier is analyzed, specifically its performance in hurling solid bodies made of electrically poor conductor materials (steel, tungsten, titanium) or nonconducting materials (glass, teflon, textolite). The skin effect is assumed to become negligible and the current density distribution to become therefore uniform by heating the accelerating conductor ("bucket"). In order to equalize the contact forces, it is necessary to make the cross-section area of the accelerating conductor equal to that of the accelerated body. On this basis, the differential equations of motion for conductor and body are formulated in the approximation of LRC circuit theory. A numerical solution of these equations on a computer by the Runge-Kutta method has yielded a set of performance characteristics, namely the action integral of the discharge current and the velocity of the hurled body as functions of the conductor+body reduced mass $\sigma_{\Sigma} = (m_1 + m_2)/m_1$ and of the normalized railotron+magnetizer inductance (ratio of inductance of capacitor bank and current leads, to total inductance of rails). These performance characteristics can be approximated with analytical power-law relations, numerical data having been obtained for a 500 kJ capacitor bank, an accelerating conductor made of D16T aluminum, and a body made of steel. From such data can be determined the bank capacitance and the discharge voltage as well as the conductor thickness for optimum acceleration and hurling of a body. Figures 5; references: 5 Russian.
[114-2415]

INTENSITY OF GHOST IMAGES FORMED BY THREE-DIMENSIONAL HOLOGRAM GENERATING
OPTICAL ELEMENTS

KORESHEV, S.N. and SEMENOV, G.B.

[Abstract] For a better design of hologram generating optics, an experi-
mental study was made of the space-energy characteristics of ghost images.
Image intensity measurements were made on bleached reflection holograms of
plane waves recorded on PE-2 layers of silver halide with light of 0.63 µm
wavelength, the diffraction efficiency during reconstruction at the Bragg
angle being 68%. Three mechanisms of spurious image formation were examined:
1) sloping of isophasal surfaces in a three-dimensional hologram; 2) internal
rereflections in a three-dimensional optical element; 3) spurious inter-
ference patterns generated by internal rereflections of light beams which form
the principal hologram structure. After ghost images formed by each mechanism
separately had been evaluated, evaluation of ghost images formed by simul-
taneous involvement of all three mechanisms during the restoration process took
into account the parallel propagation and the coherence of all additional light
beams attributable to these three mechanisms, only those of +1 diffraction
order propagating in a different direction. Under the most unfavorable condi-
tion, namely synphasal superposition of all spurious images, the resultant
intensity of the latter can be a very large percentage of the intensity of the
main image. Sloping of isophasal surfaces was found to be the major factor.
Consequently, ensuring parallel hologram surfaces should virtually eliminate
ghost images, inasmuch as internal rereflections will then only affect the
diffraction efficiency but not generate ghost images. Only taper or otherwise
nonuniform thickness of the substrate could then still cause formation of
spurious images. Figures 3; tables 3; references 5: 1 Russian, 4 Western.
[208-2415]

MEASUREMENT OF RADIATION STRENGTH OF DIELECTRIC MIRRORS EMPLOYED IN LASER
RESONATORS

BOLSHANIN, A.F., PUTILIN, E.S. and STAROVOYTOV, S.F., Leningrad Institute of
Precision Mechanics and Optics

[Abstract] The correlation is sought between the threshold laser radiation
energy density that causes visible destruction of the surface coating of
dielectric mirrors in laser resonators and the energy losses therein. It is

determined that the destruction threshold of weakly absorbing films are proportional to the energy losses of light in them. An experimental system developed to check the method is described. The experimental and analytical results were found to agree with $\pm15\%$. The method makes it possible to predict the radiation strength in different zones of dielectric mirrors nondestructively. Figures 3, tables 1, references: 6 Russian.
[249-6900]

FLUID MECHANICS

INFLUENCE OF THERMOPHYSICAL PROPERTIES OF A SURFACE ON HEAT TRANSFER IN A
TURBULENT FLOW (A REVIEW)

KURILLOV, P.L.

[Abstract] This review of the Soviet and Western literature discusses the
problem of heat exchange during turbulent flow over to a surface. Two
basically different effects must be considered: the flow of heat along the
wall when there is a temperature gradient in the direction of the flow or
transverse to the velocity vector, and another, less known, cause of the con-
jugation of temperature fields, local instability of the velocity and tempera-
ture fields due to the periodic turbulent structure of the flow near the wall.
Studies of turbulent flow near a wall have shown that short periods of strong
turbulent activity alternate with much longer periods in which the effect of
viscosity predominates. Recent studies have confirmed that eddies in the flow
do not reach the wall. Equations are presented for the ratio of heat transfer
coefficients for flow past copper and stainless steel walls. Differences in
heat transfer coefficients are estimated for flow of water past walls of
various materials. Figures 10, references 69: 42 Russian, 27 Western.
[269-6508]

PROPAGATION OF ACOUSTIC DISTURBANCES IN NONHOMOGENEOUS GAS-LIQUID SYSTEMS

AKHATOV, I.Sh., Bashkir State University imeni 40th Anniversary of October,
Ufa, and BAYKOV, V.A., Ufa Petroleum Institute

[Abstract] A study was made to determine the specifics of propagation of
acoustic disturbances in nonhomogeneous gas-liquid media. It is shown that
nonhomogeneity of the gas content through the volume of the medium and

dispersion of the sound in a bubble medium may result in deflection, focusing or defocusing of beams of sound. Figures 2, references 6: Russian. [269-6508]

ELECTRIC ARC IN DEVELOPED TURBULENT FLOW

ZHUKOV, M.F., LUKASHOV, V.P., POZDNYAKOV, B.A. and SHCHERBIK, N.M., Institute of Heat Physics, Siberian Branch, USSR Academy of Sciences, Novosibirsk

[Abstract] Results are presented from studies of a simple electric arc burning in a cylindrical channel in a developed turbulent section of a flow of gas. The change in shape of an electric arc in a channel of this type is illustrated and the radial distribution of radiation intensity and coefficient of turbulent viscosity are determined. The turbulent flow structure stabilizes the area near the center of the channel where the current is conducted. The "channel" model of a turbulent arc is found to differ significantly from the actual picture of physical processes in the electric discharge chamber. The true temperature can be estimated on the basis of experimental data. Figures 4, references 7: 5 Russian, 2 Western. [269-6508]

EXPERIMENTAL STUDY OF VIBRATIONS OF CYLINDRICAL SHELLS PARTLY FILLED WITH LIQUID

SMIRNOV, V.A., doctor of technical sciences, BUDAK, V.D., candidate of technical sciences, MESHCHERYAKOV, M.A., engineer, and NANASOV, M.P., engineer

[Abstract] Forced vibrations of a closed cylindrical shell partly filled with liquid were studied in an experiment with holographic interferometry. The shell was made of steel (Young's modulus E= 210 GPa, Poisson's ratio $\nu = 0.3$), produced on a precision lathe, was 150 mm long and 70 mm in diameter with a 0.15 mm wall thickness. The shell was placed in a horizontal position, with the right-hand base fastened to a stationary mounting plate by means of three bolts under a tension of 10 kN and with 0.3 mm thick bottom strips of an aluminum alloy (E= 71 GPa) bonded to the shell surface from its two bases

to the reinforcing hoops. The shell was tested for resonance vibrations, first empty and then half-filled with water, excitation coming from an a.c. electromagnet energized by a variable-frequency 20-10,000 Hz voltage generator and placed with its core 0.5 mm away from the lateral surface of the shell. An ILK-120 laser served as a source of monochromatic light; other instrumentation included two 2-beam oscillographs. The data reveal that the vibration modes of such a shell, of its bases and its lateral surface, are appreciably distorted by the presence of a liquid inside and the presence of a bottom ballast outside. They also reveal different vibration frequencies in zones making contact with the liquid and in zones above the liquid level. This anomaly ought to be taken into account in the design of vessels. Figures 3; references 1: Russian.
[96-2415]

DYNAMICS OF ELASTIC ISOTROPIC SPHERE MADE OF COMPRESSIBLE MATERIAL UNDER INITIALLY UNIFORM HYDROSTATIC LOAD

GUZ, A.N., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A solid sphere made of an elastic isotropic compressible material is considered with an arbitrary form of the elasticity potential, and its dynamic behavior under an initially uniform hydrostatic load is analyzed first in Lagrangian coordinates. These coordinates coincide with spherical ones in the natural state under no load, but the condition of incompressibility does not apply to the initial state of stress and strain. The linearized equations of dynamics are derived from the equation of motion with boundary conditions for stresses or displacements at the part of the surface under load. The initial state can be produced by a "tracking" load or a "dead" load, and an additional load stressing a part of the surface. Solution of the problem is continued in a system of spherical coordinates, with the vector displacement potential expressed in terms of two scalar wave potentials. The solution is obtained in a form which generalizes the theory of finite large initial strains and the theory of small initial strains. As a practical example, the free vibration modes are calculated for such a sphere under a "dead" load and under a "tracking" load. The general frequency equation splits here into two independent ones for two series of generally non-axisymmetric modes. The frequencies of all modes, even under a "tracking" load, are found to depend on the initial stresses corresponding to a uniform hydrostatic initial load. References 3: 2 Russian, 1 Western (in Russian translation).
[86-2415]

PROPAGATION OF HARMONIC ELASTIC WAVES FROM CURVILINEAR CYLINDRICAL CAVITY

PODILCHUK, Yu.N., RUBTSOV, Yu.K., and SOROKA, P.N., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Propagation of harmonic elastic waves from a curvilinear cylindrical cavity is analyzed by a method taken from the theory of geometrical optics, namely by expansion into wave eigenfunctions. The linear equation of steady-state wave motion for an ideal elastic medium without body forces is transformed into a system of Helmholtz equations, whereupon both scalar and vector displacement potentials are expanded into Debye (ray) series. The problem then reduces to two nonlinear first-order partial differential equations of the eikonal and two systems of transport equations in recursive form. The eikonal equations are solved by integration of the corresponding characteristic system of ordinary differential equations. Expressions are found for the coefficients of the (recursive) transport equations. Numerical results obtained by this method are compared with results obtained by the "boundary shape perturbation" method and the agreement is found to be close not only for short waves but also for wavelengths comparable with the cavity dimensions. The method is also applicable to the case of a normal stress which varies harmonically in time and produces plane strain of the cavity surface, as demonstrated for a cavity in the shape of an elliptical cylinder. Figures 5; references 8: 5 Russian, 3 Western (1 in Russian translation). [86-2415]

ACTION OF PLANE ACOUSTIC PRESSURE WAVE ON CYLINDRICAL SHELL FILLED WITH FLUID

PINCHUKOVA, N.I., Novosibirsk

[Abstract] A cylindrical shell filled with an ideal compressible fluid is considered and its transient response to an incident plane acoustic pressure wave is described by two systems of equations: linear equations of motion in radial and tangential displacements of the shell according to the Kirchhoff-Love theory and wave equations in radial and tangential displacements for the velocity potential in the fluid. Shell and fluid are assumed to be initially at rest, and the velocity of fluid particles in the wave after penetration is proportional to the pressure, its radial component being normal to the inside shell surface and equal to $-P_0\cos\theta$. The system of equations is solved asymptotically, after the sought functions have been expanded

into Fourier series with respect to the angular coordinate. It is also solved by conversion to a system of finite-difference equations with respect to time, where boundary conditions and fluid pressure are approximated with central differences. The size of the difference grid in space is reduced by introduction of a hypothetical boundary within the ambient medium. The algorithm of the solution has been programmed for a BESM-6 high-speed computer, to yield all pressure and velocity oscillations as well as extreme and singular points, deflection curves and adhesive stresses between shell and ambient medium. The solution has been tested on a shell made of steel, filled with water and immersed in water. Figures 6; references 6: 3 Russian, 3 Western (1 in Russian translation).
[80-2415]

UDC 533.6.011.8

THREE-DIMENSIONAL VISCOUS SHOCK LAYER IN CHEMICAL NONEQUILIBRIUM AT CATALYTIC SURFACE AND COUPLED WITH HEAT TRANSFER

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 6, Nov-Dec 85 (manuscript received 8 Jan 85) pp 140-146

GERSHBEYN, E.A. [deceased], KRUPA, V.G., and SHCHELIN, V.S., Moscow

[Abstract] A three-dimensional viscous shock layer of air at a catalytic surface is considered, taking into account chemical nonequilibrium during homogeneous reactions such as dissociation-recombination reactions and exchange reactions. Multicomponent diffusion is also taken into account, but thermal diffusion and baric diffusion are disregarded. The gaseous layer is assumed to contain N_2, N, O_2, and NO. The equations of gas dynamics in the layer and the equations of heat transfer to the surface cladding which consists of carbon (graphite) with a thin SiO_2 film are solved simultaneously, first for a thermally insulated surface and then for a surface allowing heat to penetrate. Five models of heterogeneous catalytic reactions are considered, four models of first-order reactions with constant or temperature-dependent rates and one model with Ealy-Rydeal reactions along with adsorption-desorption reactions. These equations have been solved numerically for an elliptical paraboloid entering the atmosphere at a zero angle of attack. The heat transfer to the surface at the stagnation point has been found to be approximately the same whether or not the surface is thermally insulated, which allows separating the problem of heat transfer within the body and solving the applicable equation of heat conduction either exactly or asymptotically in inverse-power series of the thermal conductivity. The hot spot is found to shift away from the stagnation point along the line where the curvature is largest and the difference between the temperatures of the two points to become largest at the altitude of 80 km. Figures 5; references 10: 7 Russian, 3 Western.
[95-2415]

SOLUTION OF FUSION PROBLEM FOR GLASSY MATERIALS ON BASIS OF COMPLETE BOUNDARY-LAYER EQUATIONS

ZNAMENSKIY, V.V. and POLYAKOV, I.N., Moscow

[Abstract] Surface melting of glassy materials and subsequent flow of the surface film are analyzed on the basis of complete boundary-layer equations applicable to surfaces with large curvature. The corresponding boundary-value problem is formulated as a two-dimensional one in a curvilinear orthogonal system of coordinates, with the two axes respectively tangent and inwardly normal to the body surface. The differential equations of steady-state hydrodynamics and heat transfer are solved for the appropriate boundary conditions, analytically with use of the applicable similarity law in the case of laminar heat transfer and by numerical methods in the case of turbulent heat transfer not subject to a similarity law as during hypersonic motion. For this case, the equations are converted to finite-difference equations, and the latter are solved by the matrix determinant method when they are linear or by the Newton method when they are nonlinear with the viscosity of the melt strongly depending on the temperature. The algorithms of the solution have been programmed in ALGOL for a BESM-6 high-speed computer, to yield the distributions of effective enthalpy and effective surface temperature, also of the gassification coefficient when evaporation takes place. Figures 5; references 12: 9 Russian, 3 Western.
[95-2415]

CHARACTERISTICS OF TRANSITION FROM LAMINAR TO TURBULENT BOUNDARY LAYER AT CONICAL SURFACE

MASLOV, A.A. and SHEVELKOV, S.G., Novosibirsk

[Abstract] An experimental study of a boundary layer at the surface of an acute circular cone in air was made, for the purpose of determining the characteristics of transition from laminar to turbulent at supersonic velocities not exceeding $N_M = 4$. Measurements were performed in the T-325 wind tunnel at the Institute of Theoretical and Applied Mechanics (Siberian Department, USSR Academy of Sciences) with a 200x200 mm^2 cross-section of the test segment. The perturbation spectra were recorded with a TPT-3 d.c. thermoanemometer and evaluated with an SK-4-56 analyzer, of particular

concern being the region of maximum mass-flow rate fluctuation within the boundary layer. Processing of the test data yielded the critical transition Reynolds number N_{R_*} as function of the unit-length Reynolds number N_{R_1} at three velocities. The results, with N_{R_1} increasing, revealed a monotonic increase of N_{R_*} at $N_M = 2$, a peaking of N_{R_*} at $N_M = 3$, and a monotonic decrease of N_{R_*} at $N_M = 4$. These findings, along with the frequency spectrum of perturbations and the dependence of pressure fluctuation energy in a free stream of N_{R_1}, are interpreted according to the theory of hydro-dynamic stability in terms of perturbation amplitude and frequency as factors determining the transition and the critical Reynolds number at which it occurs. The trends are analogous to those in a boundary layer at the surface of a plate. Figures 3; references 10: 8 Russian, 2 Western. [95-2415]

VERTICAL ENTRY OF SOLID BODIES INTO WATER

BIVIN, Yu.K., GLUKHOV, Yu.M., and PERMYAKOV, Yu.V., Moscow

[Abstract] Vertical downward entry of solid bodies from air into water was studied in an experiment in which spheres and disks were dropped so as to enter at velocities of 60-700 m/s. A rectangular tank, 0.5 m deep and 0.76x0.46 m^2 in cross-section, had been assembled with 30 mm thick plates of acrylic glass and filled with distilled water. Steel balls and duralumin balls 10 mm in diameter weighing 4 g and 1.45 g, respectively, were dropped in one series of tests; steel disks and bronze disks 10 mm in diameter weighing 2.66 g and 15.97 g, respectively, were dropped in another series of tests. Their motion was tracked with a ZhLV-2M high-speed motion-picture camera using an IFK-120 flash tube as light source, both camera and flash tube being automatically synchronized with the pneumatic testing equipment. The entry velocity was measured with photodiodes. The test results have been evaluated on a theoretical basis, in accordance with the applicable equation of motion of a solid body upon impact on the free surface of a fluid and subsequent immersion. With the aid of dimensional analysis, the experimental data yield the kinematic parameters characterizing the immersion pattern as functions of the entry velocity: drag coefficient and depth to which the magnitude of the drag, as well as the shape of the wake region, are influenced by the free surface. Figures 5; references 9: 4 Russian, 5 Western. [95-2415]

CHARACTERISTICS OF HEAT AND MASS TRANSFER ACROSS PLANES OF SYMMETRY IN BODIES
OF VARIOUS SHAPES

ZINCHENKO, V.I. and PUTYATIKA, Ye.N., Tomsk State University

[Abstract] Heat and mass transfer during laminar or turbulent three-
dimensional supersonic flow around a body with a plane of symmetry is
analyzed by appropriate description of the boundary layer, including the
metric tensor at the body surface and the corresponding system of equations
in the most general nonorthogonal curvilinear coordinates. This system of
equations is formulated with second-order precision, assuming an isotropic
eddy viscosity and taking into account injection or ejection at the surface.
The model of a turbulent boundary layer is one consisting of two regions.
Its inner region is characterized by a Prandtl profile of eddy viscosity
with VanDreest-Sebecci damping which accounts for a pressure gradient and
injection. Its outer region is characterized by a Clauser profile of eddy
viscosity, and the boundary between the two regions lies at the intersection
of both profiles. The boundary-value problem for this system of equations
is solved by numerical integration, using the iteration-interpolation method
or the Runge-Kutta method where appropriate. Calculations for an ellipsoid
of revolution have yielded the thermal flux distribution over a plane of
symmetry and its dependence on the normalized rate of gas flow past the
surface as well as on the angle of attack. For control, the solution
pertaining to laminar flow is compared with the analytical solution. A
solution is then also obtained for transitional flow. Figures 4;
references 10: 8 Russian, 2 Western.
[84-2415]

TURBULENT VELOCITY AND TEMPERATURE FIELDS IN NONISOTHERMAL WAKE BEHIND
PROLATE SOLID OF REVOLUTION

DMITRENKO, Yu.M., ZHDANOV, V.L., and KOLOVANDIN, B.A., Institute of Heat and
Mass Transfer imeni A.V. Lykov, BSSR Academy of Sciences, Minsk

[Abstract] Nonisothermal shear flow in the wake behind a prolate ellipsoid
of revolution is analyzed on the basis of experiment and theory, for the
purpose of determining its universal and shape-dependent velocity and
temperature characteristics. The model is an ellipsoid with a midspan
diameter d = 30 mm and a ratio of axes a/b = 6:1, suspended on eight tension
wires 0.2 mm in diameter inside the 3.75 m long and 0.5x0.5 m^2 cross-section

test compartment of a closed-jet wind tunnel. Tests were performed in two modes: slow jet ejection at a velocity of 14.3 m/s and fast jet ejection at a velocity of 26.9 m/s. Temperature fluctuations were measured with 55M01 and 55D01 constant-temperature thermoanemometers, average temperature was measured with a Chromel-Constantan differential thermocouple, and velocity fluctuations were measured with DISA 55R01 and 55R51 probes, after their calibration against a Pitot tube in a quiescent stream. A theoretical analysis of the data yields relations describing the turbulence characteristics, namely, the radial profiles of both average and fluctuation components of velocity and temperature as functions of the axial coordinate. With correction for the finite resolving power of probes, the analysis reveals also where along the wake asymptotic power-law relations characterizing dynamic similarity begin to hold true. Figures 5; tables 1; references 13: 4 Russian, 9 Western.
[138-2415]

INTERNAL WAVES GENERATED DURING TRANSIENT MOTION OF SOURCE IN CONTINUOUSLY STRATIFIED FLUID

STUROVA, I.V., Novosibirsk

[Abstract] Transient motion of a source along an arbitrary trajectory within a nonviscous incompressible fluid and the internal waves it produces in that fluid are considered, the density of the fluid being a monotonic continuous function of the vertical coordinate. The fundamental system of two vector equations describing three-dimensional internal waves of infinitesimal amplitude without diffusion is, in the Boussinesq approximation, reduced to a single ordinary homogeneous differential equation for the vertical motion with its Brunt-Weissal frequency. Upon introduction of the Green function in the appropriate form, the problem is solved by way of inverse Fourier and Laplace transformations. A dipole wave source is considered which simulates the motion of a sphere through an array of sources and sinks as it would in a boundless homogeneous fluid. A interesting case is transient motion of such a sphere with three-dimensional osciallations superposed on its uniform horizontal motion. The problem has been solved numerically for two simple fluid density profiles. Figures 3; tables 2; references 12: 7 Russian, 5 Western (1 in Russian translation).
[90-2415]

PRODUCTION OF HYDROGEN IN NONEQUILIBRIUM PLASMA OF MICROWAVE DISCHARGE

MELIK-ASLANOVA, T.A., RUSANOV, V.D., FRIDMAN, A.A., ABBASOV, A.S.,
POTAPKIN, B.V., and SHILNIKOV, V.I., Institute of Physics

[Abstract] Use of low-temperature nonequilibrium plasmas in the technology
of chemical processes such as dissociation of water vapor for production of
hydrogen is examined from the standpoint of feasibility and optimization.
The most efficient mechanism of direct dissociation $H_2O \rightarrow H_2 + \frac{1}{2}O_2$, $\Delta h = 2.6$ eV
is through excitation of vibrational degrees of freedom, which proceeds in
three stages: excitation of lower vibrational levels - population of highly
excited states during VV-relaxation - chemical reactions with participation
of excited molecules. Dissociation of water in a nonequilibrium plasma can
occur according to a straight-through chain reaction in which H_2O_2 appears as
an intermediate product. A quantitative analysis of this process is based on
equations of gas dynamics and chemical kinetics which mathematically describe
dissociation of water vapor in a supersonic stream of nonequilibrium plasma
generated by microwave glow discharge, i.e., one-dimensional steady-state flow
of a relaxing multicomponent gas through a reactor with slightly varying
cross-sectional area. This system of equations, after a simple transforma-
tion introducing the concentrations of reaction products and their rates of
change, are most reliably solved by a "stiff" method using the "predictor-
corrector" concept according to C.W. Gear (1971). For verification, the
results have been checked against results of numerical integration by other
methods applicable to nonlinear differential equations (Adams scheme of
sixth-order precision, Runge-Kutta scheme of fourth-order precision, modified
Runge-Kutta-Felberg scheme). Calculations have yielded the concentrations
of reaction products as functions of time and the dependence of energy
efficiency and water conversion level on the degree of ionization, on the
input energy per molecule, and on the velocity of the plasma stream. The
trend of these characteristics indicates that the water dissociation process
can be optimized by addition of an inert diluent to the initial vapor.
Figures 4; references 7: 4 Russian, 3 Western (2 in Russian translation).
[202-2415]

ASYMPTOTIC ANALYSIS OF FREE AXISYMMETRIC VIBRATIONS OF CYLINDRICAL SHELL WITH
FILLER AND GAS TAKING INTO ACCOUNT INERTIAL PROPERTIES OF FILLER AND GAS

LATIFOV, F.S. and NESHCHADIM, T.P., Institute of Mathematics and Mechanics,
AzSSR Academy of Sciences

[Abstract] Free axisymmetric vibrations of a closed circular cylindrical
shell containing a solid filler and a gas are analyzed "semiexactly," the
shell being treated in accordance with the theory of moments and the filler
being treated in accordance with the theory of elasticity. The system of
five equations, two describing the motion of the shell and two describing the
motion of the filler, and the Helmholtz equation for the gas, are solved for
boundary conditions in displacements and stresses corresponding to a shell
constrained by hinge supports at both ends. The solution is sought in space
and time harmonics of longitudinal and transverse displacements, assuming
that the shell material is much stiffer than the filler material. The
solution is obtained by the asymptotic method, which yields the lower
frequencies. References 5: 3 Russian, 2 Western (both in Russian
translation).
[202-2415]

FLOW OF PULSATING JET ABOUT RAW COTTON BOLL

BAKHRAMOV, A.M., KARIMOV, A.R., and MUSABEKOV, B.I., Uzbek Kibernetika
Scientific-Production Association, Uzbek SSR Academy of Sciences

[Abstract] The aerodynamic characteristics of the flow of a pulsating jet
about an open raw cotton boll are investigated as a part of a study involved
in the development of pneumatic pulsating cotton picking machines. An
equation is derived that describes the coefficient of aerodynamic force as a
function of the Strouhal number of the boll and the time required to extract
the raw cotton from the boll with a pulsating jet flowing about the open
boll. The effective removal of raw cotton from the boll is found to depend
upon the initial thickness of the pulsating stream, the nature of its flow,
and the Strouhal number. The cotton boll has its own amplitude-frequency
characteristics, which influence the removal of the raw cotton by a
pulsating jet. Figures 3; references: 5 Russian.
[225-6900]

AN ANALYTICAL SOLUTION FOR A STEADY SELF-SIMILAR TURBULENT JET OF
INCOMPRESSIBLE LIQUID

GOSTINTSEV, Yu.A., FAYZIYEV, R.A., and SHUMAYEV, Z.Sh., Institute of Chemical
Physics, USSR Academy of Sciences

[Abstract] A constrained convective jet of incompressible liquid is
investigated with the help of simple analytical expressions for the flow
parameters as a function of the coordinates. The hypothesis regarding the
coefficient of turbulent viscosity of freely convective jet flows derived
elsewhere by the author is found to describe the transfer processes in a
constrained convective jet of incompressible liquid. Figures 4; tables 1;
references 17: 16 Russian, 1 Western.
[225-6900]

ADSORPTION-DESORPTION PROCESSES AT SURFACE OF SOLID BODY

AGEYEV, V.N., doctor of physico-mathematical sciences, and ZANDBERT, E.Ya., doctor of physico-mathematical sciences

[Abstract] Extensive studies of thermally activated adsorption and desorption processes, as well as interparticle interactions at the surface of transition-group and platinum-group metals, were made by bascially two methods, namely, thermodesorption spectrometry at lower temperatures and surface ionization at higher temperatures. The first of these methods, a sudden raising of the adsorbent temperature causing some of the gaseous adsorbate to be desorbed from the surface and to raise the total gas pressure in the measuring instrument, yields information about adhesion coefficients, adsorption activation energy and adsorption kinetics, chemical reactions at the surface, and surface concentration of adsorbate particles. Chemical reactions occur either according to the adsorption mechanism when both reactants have been adsorbed or by the impact mechanism when one reactant has been chemosorbed and the other reactant enters from the gaseous phase. Surface ionization, emission of adsorbate ions from the surface during thermal desorption in an accelerating electric field which can raise the probability of ionization and lower the ionization temperature, yields information about surface processes under nonsteady conditions. This information includes all kinetic characteristics of thermal desorption of ions and atoms, entropy coefficients, desorption activation energy for charged and neutral particles, and surface lifetime relative to desorption time of each kind of particle as well as the temperature dependence of that lifetime. Figures 7; references 15: 14 Russian, 1 Western.
[113-2415]

IMPACT ON VISCOELASTIC MULTILAYER COMPOSITE MATERIAL

NURIYEV, B.R., Institute of Mathematics and Mechanics, AzSSR Academy of Sciences

[Abstract] Propagation of plane waves through a viscoelastic or elastic multilayer composite material normal to the layering following an impact on one of its surfaces normally to it is analyzed, for the case of a material which consists of two kinds of identical homogeneous layers in a periodically alternating array with the different layers having generally different thicknesses. The problem reduces to a second-order partial differential equation of one-dimensional motion in a continuous medium and an integral equation of state with a relaxation kernel for each kind of layer. Following a Laplace transformation, an exact analytical solution is obtained in the form of series which for any finite period of time contain a finite number of terms. References 8: 4 Russian, 4 Western.
[91-2415]

TESTING AND MATERIALS

RELIABILITY AND SAFETY FACTOR OF CERAMIC MATERIAL

KRASULIN, Yu.L. and BARINOV, S.M., Institute of Metallurgy imeni A.A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] The performance of ceramic materials in load-bearing structures is considered from the standpoint of load capacity and reliability. Failure is in this case associated with brittle fracture, and reliability is in the deterministic approximation characterized by probability $p = 0$ or $p = 1$ of reaching the ultimate state which precedes fracture. These concepts are applied specifically to ceramic materials under thermal tensile stresses, considering that these materials are not perfectly brittle and that at some temperature there occurs a transition from the linearly elastic state to the elastoplastic state. Both deformation and cracking processes in real ceramic materials, specifically refractory oxides, are analyzed on the basis of applicable stress-strain diagrams, the purpose being to determine their resistance to fracture in accordance with work-of-fracture and loss-of-stability criteria. A safety factor is then established which takes into account the overload capacity of a structure and thus its ability to relax stress concentrations. This safety factor, a semiempirical quantity with correction for brittleness, serves as criterion for replacement of metals with ceramics in machine design. Figures 2; references 15: 12 Russian, 3 Western (1 in Russian translation).
[274-2415]

EFFECTIVE RHEOLOGICAL PROPERTIES OF A DISPERSE MIXTURE OF VISCOELASTIC MATERIALS

BUYEVICH, Yu.A. and ZUBAREV, A.Yu., Urals State University imeni A.M. Gorkiy, Sverdlovsk

[Abstract] A study was made of the dynamic behavior of a composite material consisting of a continuous viscoelastic matrix with spherical inclusions of

another viscoelastic material distributed within it. The properties of an elastic medium with inclusions containing a Newtonian viscous fluid, which can be described by a model of actual water-impregnated porous layers, is studied in greatest detail. The problem of determining the bulk modulus and shear modulus, as well as the shear and volumetric viscosity of such a medium, is analyzed. Figures 4; references 22: 11 Russian, 11 Western. [269-6508]

BREAKDOWN OF ORGANIC-BASED COMPOSITE MATERIAL IN HIGH-TEMPERATURE GAS STREAM

NIKITIN, P.V., OVSYANNIKOV, V.M., and KHOLODKOV, N.V.

[Abstract] Previous studies have widely used a model of the boundary layer which assumes frozen chemical reactions within the flow, or which assumes a catalytic wall, leading to equilibrium chemical composition of the gas at the surface of the body. The model with a chemical equilibrium boundary layer apparently corresponds more closely to actual conditions, though a previous work indicated that the thermal flux incident on the surface for either case differed by only 7-8% for a dissociated air boundary layer without breakdown. This article compares the calculated and the experimental data on rate of breakdown of a composite material (textolite cloth-based laminate) in high temperature gas streams with deceleration enthalpy of $14 - 73 \times 10^6$ J/kg. The chemical composition of the boundary layer (H, C, N, and O compounds from the breakdown of the textolite) was determined. The high temperature stream, incident on textolite cylinders 14 to 30 mm in diameter, was created by an electric heater with a high-current arc stabilized with liquid air. The difference between calculated and experimental results did not exceed 25%. Figures 4; references 8: 5 Russian, 3 Western. [269-6508]

FORCED VIBRATIONS OF PIEZOCERAMIC HOLLOW CYLINDER WITH AXIAL POLARIZATION

BOLKISEV, A.M. and SHULGA, N.A., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] A piezoceramic hollow cylinder with axial polarization is considered, generally with or, in a special case, without short-circuited electrodes covering its outside and inside lateral surfaces. Steady-state axisymmetric generally acoustoelectric vibrations of such a cylinder excited

by harmonically varying normal stresses on its outside lateral surface are
determined from the corresponding equations of motion and electrostatics in
a cyclindrical system of coordinates, taking into account relations between
the physical properties of such a cylinder. This closed system of equations
is solved for components of u_r, u_z of the displacement vector, components
σ_{rr}, σ_{rz} of the stress tensor, component D_r of the electric induction, and the
electric field potential $\emptyset$. With these functions expanded into trigonometric
series and satisfying given boundary conditions, the original algebraic
equations are transformed into normal ordinary differential ones which are
integrated by the numerical method of discrete orthogonalization. The result
yields the amplitude-frequency characteristics of the displacements of points
on the median surface of the cylinder at any location along the axial
coordinate, specifically at the bases and at the center, also the amplitudes
of all those mechanical and electrical quantities across the cylinder wall
in any section (bases, center) at some given frequencies below resonance.
Calculations are made in dimensionless form. Figures 3; references 6:
5 Russian, 1 Western (in Russian translation).
[86-2415]

GEOMETRICALLY NONLINEAR SUBCRITICAL STATE OF ANISOTROPIC SHELLS

RIKARDS, R.B. and CHATE, A.K., Riga Polytechnic Institute

[Abstract] The geometrically nonlinear subcritical state of multilayer
anisotropic shells is analyzed on the basis of the appropriate nonlinear
Timoshenko theory, with finite-element representation using a second-order
isoparametric triangle with 36 degrees of freedom. The state of equilibrium
under nonlinear deformation is determined from the principle of minimum
potential energy, according to the quadratic approximation variant of the
Newton method, whereupon the matrices of secant stiffness and tangential
stiffness are determined in curvilinear normal coordinates on the basis of
the appropriate Timoshenko hypothesis. As a practical example, numerical
results are obtained for the nonlinear deformation of a transversely isotropic
cylindrical panel clamped around its periphery and loaded by external
pressure, also of a horizontal cylindrical panel freely supported around its
periphery and loaded by a uniform vertical force. Figures 2; references 15:
3 Russian, 12 Western (1 in Russian translation).
[86-2415]

AUTOMATIC TEST STAND FOR DETERMINING ALL THERMOPHYSICAL PROPERTIES OF
MATERIALS UNDER DYNAMIC CONDITIONS OVER 120-700 K TEMPERATURE RANGE

KOZIN, V.M., SOKOLOV, G.Ya. and PLATUNOV, Ye.S., Department of Physics,
Leningrad Institute of Technology of the Refrigeration Industry

[Abstract] An automatic test stand has been developed and built for com-
prehensive and accurate measurement of the thermophysical properties of solid
materials aver the 175-673 K temperature range, adaptable to materials cover-
ing the 0.1-100 W/(m·K) range of thermal conductivity. Specimens in the form
of cylinders or disks are monotonically heated at both ends with different
intensities so that an axial temperature gradient is produced. The electric
power of each heater, the temperature drop across the specimen, and the heat-
ing rate are measured. From the readings, thermal conductivity and specific
heat are calculated. Measurements can be made under dynamic conditions with
a high-speed digital readout, for determining the transient characteristics
of the thermophysical properties. The thermal cell is an insulated adiabatic
vessel containing the specimen and both heaters with thermocouples, a
thermopile, and two guard rings. The electronic automation system includes a
set of precision amplifiers, a set of temperature regulators, an analog-to-
digital converter, a microprocessor with a control unit and a control
microprogrammer, a read-only memory, and a data output unit. Data are pro-
cessed for digital display, recording by an XY-plotter, monitoring the
operation, and printout. The test stand can operate in three keyboard-
selectable modes: "preparation," "calibration," "measurement." Input data
for "preparation," namely, dimensions and mass of the specimen as well
as the upper temperature limit, are entered into a direct-access memory.
"Calibration" is done against constants characterizing the thermal cell.
"Measurement" yields the temperature characteristics of thermophysical
properties. Thermal conductivity (in the 0.1-20 W/(m·K) range) and specific
heat were measured to within 5% over the 120-700 K temperature range.
Figures 3; references: 4 Russian.
[348-2415]

CALCULATION OF TEMPERATURE OF PIEZOCERAMIC LOW-FREQUENCY TRANSDUCERS

BOGOMOLNYY, V.M. and DIKAREV, G.P., Department of Engineering Mechanics,
Moscow Institute of Technology

[Abstract] The problem of determining the temperature is solved analytically
for a cylindrical dielectric transducer of finite length in a constant

electric field. Calculations are based on the equation of heat transfer, which yields the steady-state temperature rise explicitly as the sum of three components corresponding respectively to dielectric losses, mechanical losses, and coupled mechanical-piezoelectric losses. A low-frequency transducer of this kind is considered and, accordingly, its state of stress and strain during free vibrations in the lowest-order deformation mode of its median surface. For a transducer made of TsTS-19 ceramic in the form of a hollow cylinder (mean diameter 28 mm, length 20 mm, wall thickness 2 mm), excited on the electrical side by a voltage of 70 V at a frequency of 15 kHz, calculations by this method yield a temperature rise of 0.98°C. The measured temperature rise was 1.27°C. Figures 1; references 7: 3 Russian, 4 Western (1 in Russian translation).
[348-2415]

UDC 778.38:621.375.826:681.2

EVALUATION OF LASER-BEAM HARDENING OF INSTRUMENT PARTS BY HOLOGRAPHIC METHOD

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 85 pp 16-18

SUMINOV, V.M., GOLDBERG, M.M., SHANIN, V.I. and SOKOLOV, S.V.

[Abstract] Double-exposure holographic intergerometry is proposed for evaluation of the customarily 0.1-0.5 mm deep hardening of parts by laser-beam treatment. The procedure, designed specifically for quality control of instrument parts, involves recording the elastic properties before and after treatment and using the difference as indicator of the hardening effect. This technique was applied experimentally to 1.8 mm thick and 20×10 mm^2 large specimens of 15CrMo steel. They were treated with a "Kvant-12" industrial laser, with an irradiation power density of 30 W/cm^2 and a 0.5 overlap factor. They were then stacked into a column with the lower end rigidly clamped, for inspection with a special 2-beam holographic interferometer while under a fixed bending load of controllable magnitude applied at the free upper end. The optimum clamping force and bending moment for this test had been established by preliminary measurements, 15 N and 0.1 N·cm, respectively, to ensure elastic deformation of the steel well within the linear range. The absolute hardness after treatment will be $H = kH_0$ (H_0 - known initial hardness, $k - x_{a0}/x_a$, x_{a0} - average number of interference fringes before treatment, x_a - average number of interference fringes after treatment). Figures 1; references 4: 3 Russian, 1 Western (in Russian translation).
[130-2415]

MATHEMATICAL MODEL OF COMPOSITE MATERIAL WITH FIBROUS STRUCTURE

MANIYA, R.P., PREOBRAZHENSKIY, I.N., PREOBRAZHENSKIY, P.I. and KHASHBA, G.N., Georgian Institute of Subtropical Economy

[Abstract] A theory and a model of a fibrous composite material are constructed, for the purpose of establishing the dependence of its mechanical behavior on the elastic properties of its components as well as on their volume ratio and their spatial configuration. In the model, the reinforcing fibers are assumed to be continuous and macroscopically homogeneous and transversely isotropic material; both reinforcement and binder are linearly elastic as well and in perfect contact; additional stresses produced because the two component materials have different Poisson ratios are negligible; and under a load acting perpendicularly to the fibers, the stresses in the two components are equal, but their strains are proportional to their volume fractions. On the basis of this model, with the aid of the Heaviside function and the generalized Hooke's law, an equation is derived for the deflection curve of such a material. Figures 2; references: 2 Russian. [352-2415]

DEPENDENCE OF TENSILE STRENGTH OF BORON-ALUMINUM COMPOSITE ON INTEGRITY OF FIBERS

GUKASYAN, L.Ye., NOZADZE, D.A. and MEZVRISHVILI, I.Dzh., Georgian Polytechnic Institute imeni V.I. Lenin

[Abstract] The effect which crushing of fibers during compaction and rolling of a composite material has on the tensile strength of the product is evaluated by stress analysis, taking into account that the fraction of fibers crushed is generally not the same in all layers. First is considered cumulative fracture, with the fraction of fibers crushed not larger than the maximum allowable. Next is considered noncumulative fracture, with the useful cross-section gradually decreasing in the process. Expressions for the critical stress under which all fibers will break are derived for each case. Theoretical predictions according to these models have been verified experimentally for boral produced by rolling in the direction of fibers and containing various volume fractions of B_4C fibers over the 0.2-0.46 range. Figures 2; references 5: 4 Russian, 1 Western. [294-2415]

PRODUCTION OF ARSENIC OXIDE FROM METALLIC ARSENIC

RTSKHILADZE, V.G., AVALIANI, A.T., PKHACHIASHVILI, M.Sh., AGLADZE, I.I., KERESELIDZE, M.V. and RTSKHILADZE, D.Sh., Institute of Metallurgy imeni USSR Semicentennial, GSSR Academy of Sciences

[Abstract] A new method of producing extra-pure As_2O_3 ("white arsenic") for fiber optics and other applications is proposed, namely, by thermal oxidation of metallic As: heating in a stream of oxygen. The equipment consists of a horizontal quartz-tube reactor containing a dish with As powder and placed inside a tubular electrical resistance furnace. Oxygen enters at one end and As_2O_3 vapor leaves at the other end, passes through a water-cooled quartz-tube condenser, and is collected in a buffer vessel with an exhaust to an alkali solution. The optimum temperature range for this process is 280-310°C, the yield being much lower at lower temperatures and As_2O_3 vapor being ejected from the condensation zone at higher temperatures. For a batch of 30-50 g As powder in any size fraction within the 0.1-5 mm range, the optimum oxygen rate is 0.15-0.25 l/min, for 60-120 min, a lower rate decreasing the yield, and a higher rate causing ejection of As_2O_3 vapor from the condensation zone. The yield depends largely on the process duration at 280°C and hardly at all at 310°C. Chemical and spectral analysis of the As_2O_3 condensate indicate a 99.99% pure product. Figures 1; tables 1; references: 3 Russian. [352-2415]

THERMOPHYSICAL CHARACTERISTICS OF COMPOSITE POLYMER MATERIALS

SENDEROVICH, R.B. and PERVUSHIN, Yu.S., Ufa Institute of Aviation imeni Sergo Ordzhonikidze

[Abstract] A method of determining the thermophysical characteristics of destructible composite polymer coatings for thermal protection is proposed which covers the 300-2100 K temperature range, classical methods not being applicable at temperatures above the thermal decomposition point. The inverse heat conduction problem is solved with an extra term $- \Delta Q = q\frac{\partial \rho}{\partial \tau}$ (q - thermal flux, ρ - density of material, τ - time) added on the right-hand side of the nonlinear equation of heat conduction to represent the thermal effect of physico-chemical transformations. A coating is treated as a plate thermally insulated on one side. The temperature data for solving the problem are obtained experimentally, by measurement of the temperature distribution over the coating thickness and the temperature variation in time.

A special test stand has been designed and built for this purpose. Its main components are a high-temperature chamber with a high-temperature 65 kW - 10 kHz induction heater inside, both made of copper, the latter connected to a semiconductor-type high-frequency transducer which together with a thermo-couple on the specimen constitute the principal elements of an automatic heating programmer, also an analytical balance with another transducer which converts scale movements to electric signals for measurement of the thermo-gravimetric characteristic of a coating with attendant recording of temperature-time curves through another thermocouple on the specimen and change-of-weight curves. The inductor-heater is water cooled and mounted on a ceramic plate at the bottom of the chamber with centering devices and with lateral thermally insulating ceramic shields. The chamber is filled with argon, a chemically inert medium. This equipment is used for testing various glass-plastic materials under monotonic heating, with Chromel-Alumel thermocouples in the 300-1400 K temperature range and tungsten-rhenium thermocouples in the 1400-2100 K temperature range. Figures 1; references: 17 Russian.
[97-2415]

CHARACTERISTICS OF HEAT TRANSMISSION THROUGH COMPOSITE THERMAL-PROTECTION MATERIAL

OKHAPKIN, A.S.

[Abstract] Two procedures for determining the transient heat transmission characteristics of composite thermal-protection materials and especially their thermal conductivity are compared, one based on solving the inverse problem of heat and mass transfer by processing of experimental data, and the con-ventional procedure based on monotonic heating. The inverse problem is solved by space-time discretization of the temperature field and parametrization of that temperature dependence in a system of basis functions with use of cubic B-splines, for minimization of the target functional representing the differences between calculated and measured temperatures as a time integral of these differences squared by the method of steepest descent. This was done for two cylindrical specimens of such a composite material inserted through a hole in a square plate of the same material with thermally insulated edges. They were heated radiatively inside a vacuum chamber and temperature measurements were made using XA_{68} Chromel-Alumel thermocouples with an isothermal segment 150 times longer than the 0.1 mm diameter of their electrodes. The experimental data have been processed for estimating the accuracy of this solution to the inverse problem and for comparison with the temperature dependence of the thermal conductivity obtained by the method of monotonic heating. The two methods are found to yield quite different results for composite thermal-protection materials. Figures 2; tables 2; references: 6 Russian.
[97-2415]

THERMOPHYSICAL PROPERTIES OF TRANSLUCENT MATERIALS

PROSUNTSOV, P.V. and REZNIK, S.V., Moscow Higher Technical School imeni
N.E. Bauman

[Abstract] Known experimental methods of determining the thermo-physical
properties of optical materials are not adequate for semitranslucent
dispersive materials, mainly because such materials are usually poor heat
conductors and the mathematical models of radiative-conductive heat transfer
on which these methods are based do not account for multiple scattering of
radiation by both emitting and absorbing media. A physical-mathematical model
is therefore proposed which will yield a more adequate solution to the inverse
problem of finding this heat transfer coefficient for such materials, taking
into account test and measurement conditions. A radiation flux of known
intensity and spectral content is assumed to impinge on the front surface of a
flat plate made of an isotropic translucent dispersive material and heat it,
while the back surface is thermally insulated. The coefficients of heat
transfer to the gaseous ambient medium and the temperature dependence of
optical properties of the material (refractive index, absorption coefficient,
scattering coefficient) are given. From thermograms taken at one or several
points as temperature indicators, the temperature dependence of the thermal
conductivity and the specific heat of the material is calculated by solving
the corresponding system of equations for the appropriate initial and boundary
conditions. Considering that the equation of radiation transfer is an
integro-differential one and difficult to solve exactly, the method of
moments in the binomial approximation is used for subsequent solution of the
entire system of equations by a numerical scheme with cubic B-splines. This
ensures an accuracy within 10% for materials with the ratio of scattering
coefficient to absorption coefficient larger than 5. Figures 4; references:
10 Russian.
[97-2415]

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